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SULPHUR

THE MAGAZINE OF WORLD SULPHUR INDUSTRY

contents

		page
Europe's Trade in Pyrites		1
Spain, the Largest Producer		1
Difficulties in Cyprus Pyrites Industry in 1959		5
New Sulphonation Process developed in Israel		8
Prices and Trends:		
Signs of Stability in World Sulphur Prices		9
Freight Charterings and Rates		13
U.S. Frasch Sulphur Production expected to be 10% up in 1960		15
Decline in Mexican Sulphur Production		20
Growing Importance of Recovered Sulphur in Japan		23
Australia's Growing Use of Brimstone in First-half 1960		25
Sulphur Production in Italy		27
Krell Zeolite Adsorption Process Recovers Sulphur from Sour Gas		28
Trans-Jeff Chemical's Sulphur Recovery Unit		31
Irish Chemical Industry to have £4 million Sulphuric Acid Plant		32
New Sulphur Extraction Process Developed by Delhi-Taylor		33
New Gas Sweetening Processes—Stretford and Catacarb		35
CURRENT EVENTS		
Eire	Goulding's Marina Acid Plant on Stream	38
United States	Sulphur Dioxide in Tight Supply	38
Austria	New Superphosphate Plant in Styria	39
	Donau Chemie's New Acid Plant	39
Morocco	Safi's Sulphuric Acid and Superphosphate Plans	39
Egypt	Simon-Carves Acid Plant for Kafr El Zayat	39
Afghanistan	Refined Sulphur Projects	40
Brazil	Sulphuric Acid Plant for Ouro Preto	40
Argentina	Sulphur Recovery Unit ordered	40
COMPANY REPORTS		
Gulf Sulphur Corporation's Proposed Merger and Financial Reorganisation		41
Jefferson Lake Sulphur Express Concern at Sulphur Pricing Policies		41
Purification of Gases Main Item on the Gas Council's Research Programme		42
Statistical Appendix		43-44
Index to Advertisers		xix

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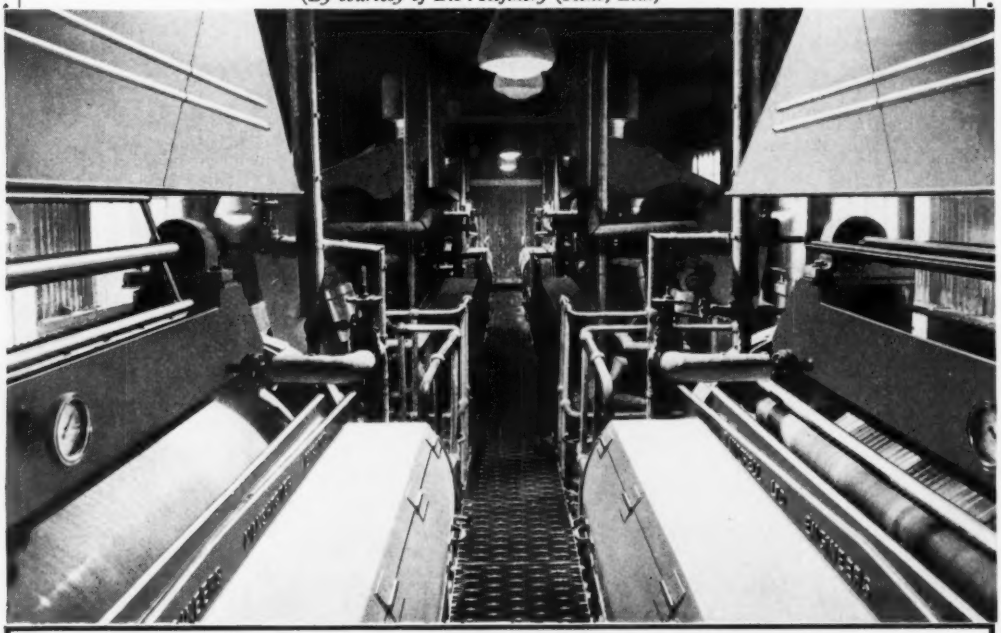

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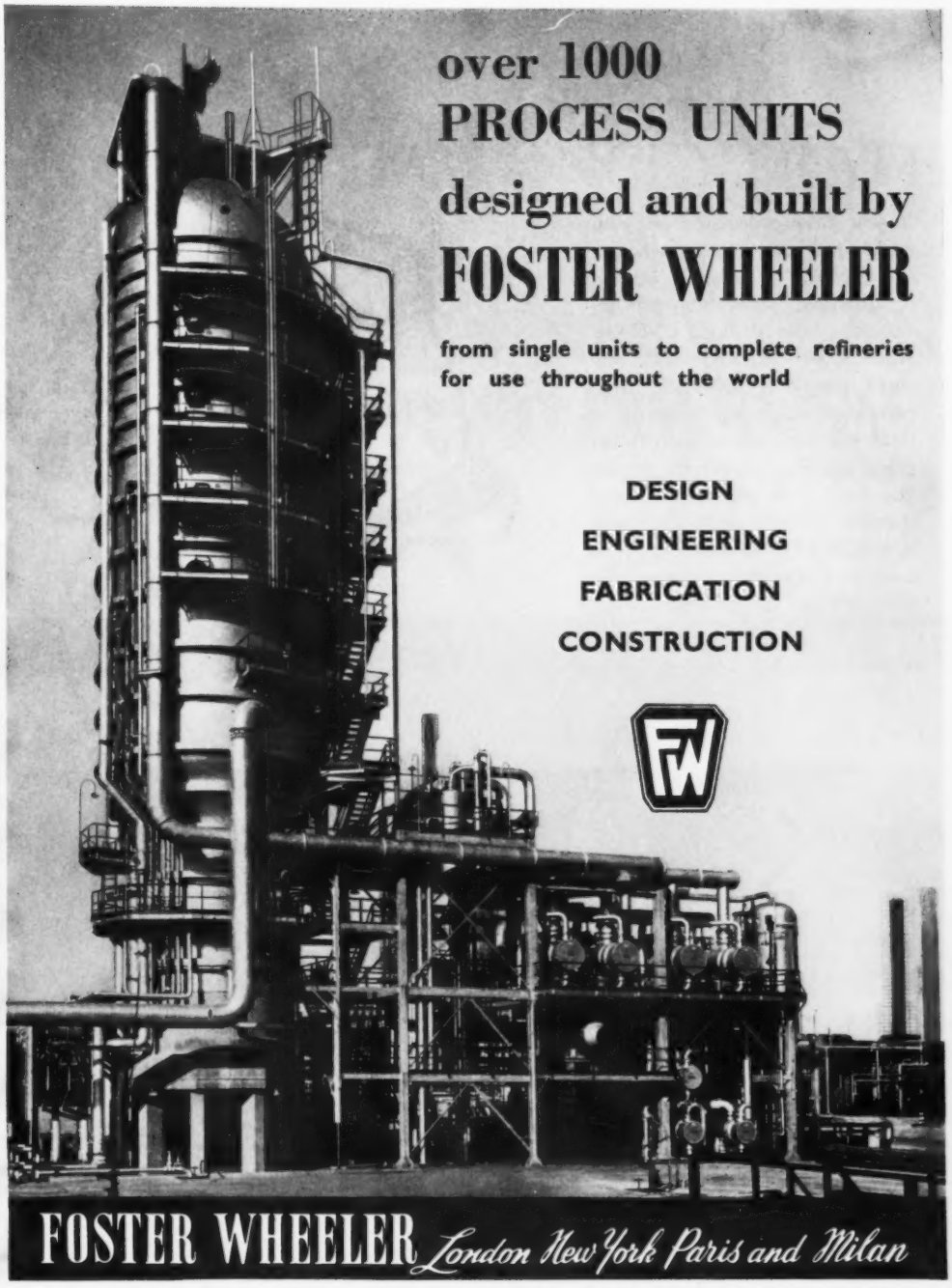
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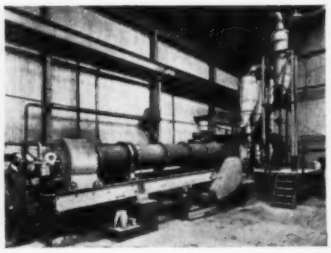

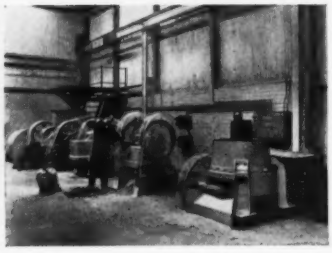

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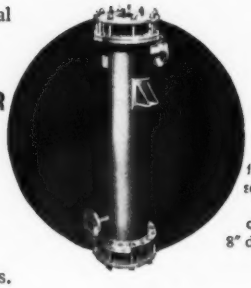

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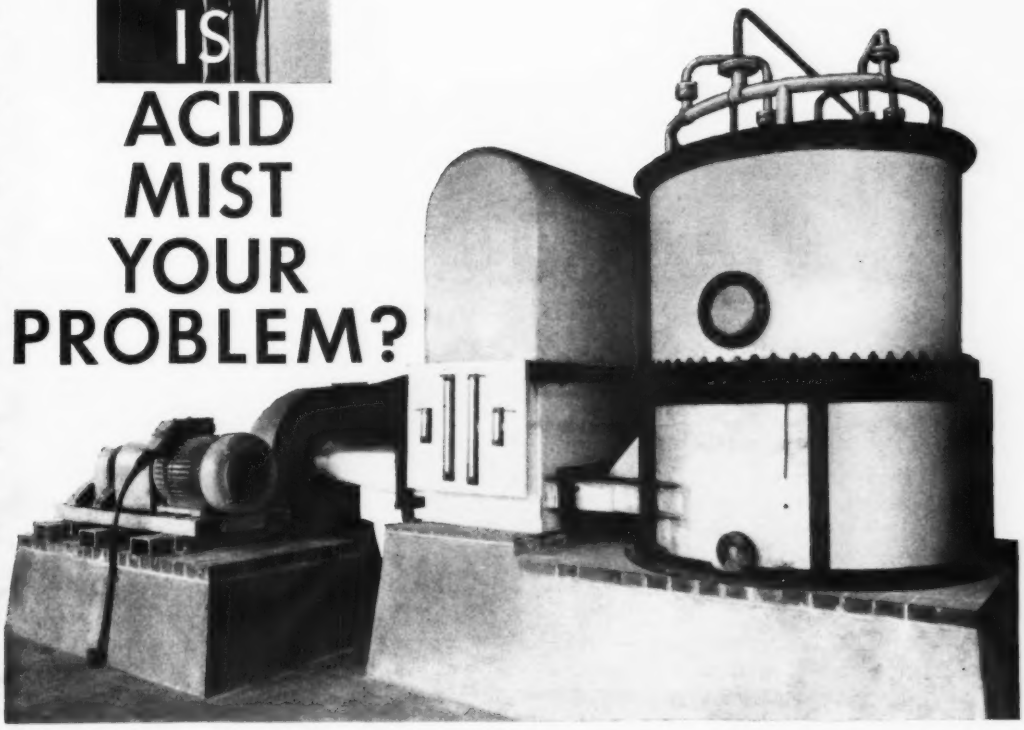

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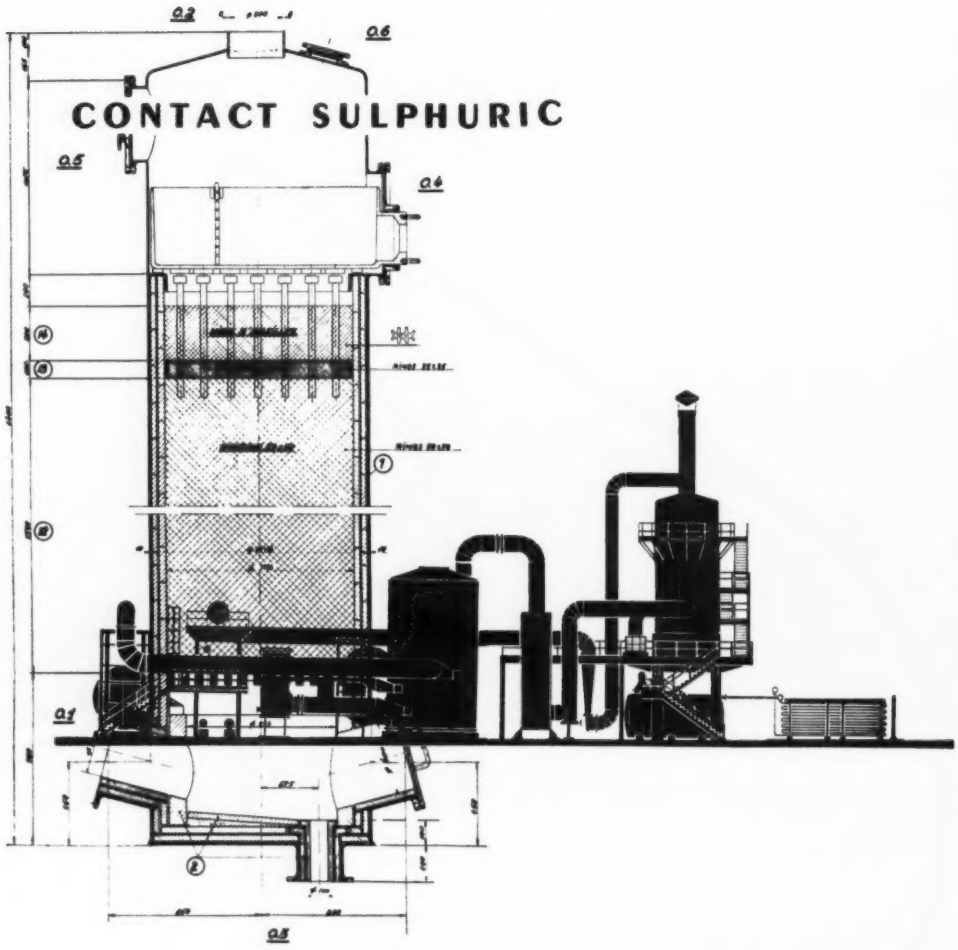

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Europe's Trade in Pyrites

Spain the largest producer

Tharsis Sulphur's opencast mine at Catañas looking east and showing the top of the ore body

TRADE in pyrites in Europe is predominantly of intra-European origin which is occasionally supplemented by small quantities from Canada and Cuba. Spain is traditionally Europe's largest producer and exporter, although since the end of World War II Cypriot exports of pyrites have grown to just over one million tonnes so that she now exports almost as much as Spain. Smaller regular exporters, but nonetheless important to the European supply pattern, are Norway and Portugal and to a lesser extent Sweden, Italy and Finland. The only other production in Europe is in France and Germany, but this, of course, does not enter international trade. It is estimated that in 1959 the four principal pyrites supplying countries met about 95% of European trade in pyrites and some 75% of the pyrites consumed in Europe.

The Industry's Difficulties

The pyrites industry during the past three years has been faced with many difficulties, perhaps the greatest being the price war between the Frasch sulphur producers. This led to a lowering of the unit price of brimstone which meant that if pyrites were to maintain their relative position in the market, the unit price of sulphur contained in pyrites also had to be lowered; in consequence there were several price reductions in the period 1957-1959 bringing the price from 105s. to 60s. per tonne f.o.b. In respect of the cost of sulphur in pyrites there are, however, some favourable aspects: (a) the cost of freight applies only in part to sulphur; (b) the metal value of the cinder—iron and copper—represents a source of revenue. Under "normal" freight market conditions and with the shorter haul for pyrites to consumer markets the cost of freight per unit of sulphur should swing from brimstone in favour of pyrites. When brimstone became freely available in the mid 1950's, its price declined and pyrites demand fell off sharply. This was due to tangible as well as intangible factors; notably the pyrites price had been too high for too long; costs of replacement or new roasters were up 2½ times those of brimstone burners; the labour costs in Europe has risen substantially; brimstone use offered easier operating conditions, being cleaner and having fewer technical problems associated with it.

The downward adjustment of pyrites prices coupled with favourable residues values remedied the adverse price comparison by 1959. At the same time technical innovations initiated in the early 1950's were now beginning to operate reliably and efficiently. The notable development was the fluidized bed roaster and the next two or three years saw additional techniques incorporated such as extensive instrumentation and heat recovery not only in fluid bed roasters but also in

multi-hearth furnaces. This meant that pyrites could be competitive with brimstone, be it for sulphuric acid manufacture or sulphur dioxide generation. The latest developments in Sweden and West Germany permit the fluidized bed roasting, yielding a non-arsenical iron residue from arsenical pyrites. To Spain, exporting almost exclusively arsenical pyrites, this is of the utmost importance.

It is interesting to note that within as short a span of time as the last decade the emphasis has changed from brimstone to pyrites during the "sulphur crisis" in the early 1950's, followed by pressure to return to cheap supplies of brimstone, while by 1959 pyrites were once more re-entering the picture. This cycle, though not as pronounced, has been a notable feature of the sulphur industry since the turn of the century.

The current technical developments in the use of pyrites coupled with the flexible price policy is encouraging for the pyrites producers and within the next few years trade and consumption of pyrites should increase, although probably not so fast as the anticipated rise in brimstone consumption. The establishment of the current trend will—making allowances for the differences in mining techniques and finance —expand their operations economically.

Pyrites Production in Spain

Spanish production of pyrites is only exceeded by Japan, but on account of the superior quality of material and the dependence of the industry on European outlets she may be regarded as the world's premier producer and exporter.

In 1959 production of pyrites totalled 2,110,157 tonnes, fractionally higher than the previous year and comprised 1,230,107 tonnes iron pyrites and 880,050 tonnes cupreous pyrites. The proportion of cupreous material to iron pyrites has risen steeply since 1955 from just over 10% to 65% in 1959 and forms part of the world wide trend to produce this material following the steep rise in copper prices in the mid-1950's. The gearing of the cinders treatment plants to process this material has meant that the demand for cinders containing 1%-3% copper has been well maintained and has been an inducement to acid makers to use cupreous pyrites.

Production data for the past three years is given in Table I below.

Higher Grades of Cupreous Material

It will be seen that following the decline in 1958 of about 10% compared with the previous year, production of the various materials has stabilized at about 2.1 million tonnes and provisional data for 1960 indicates little change. Another feature is the expansion of output of higher grades of cupreous material and the increasing volume of flotation pyrites produced. The latter originate in part, in connection with production of non-ferrous metals. Cia Asturiana de Minas account for just under one-half of this total and at their sulphide ore treatment plant in Santander produce some 60,659 tonnes. Other companies producing this material by flotation of metal sulphides are San Telmo Iberica S.A., Cia Nacional de Piritas S.A., Hidro Nitro Espanola S.A. and Industrias Reunidas Minera Metalurgicas. At Rio Tinto the material produced by heavy media separation and known as "confines" is obtained from low grade washed ore stocks from which the copper has been leached.

The Spanish pyrites industry is dominated by two companies who between them govern two-thirds of total output. The larger of the two companies is the Cia Española de Minas do Rio Tinto S.A. which in 1959 produced some 793,667 tonnes pyrites (906,168 tonnes in 1958) of which about 75% was of the cupreous material, the remainder being iron pyrites.

TABLE I

Pyrites Production 1957-1960*

	1957	1958	1959	Jan.-June 1960
Iron pyrites	**1,351,875**	**1,273,222**	**1,230,107**	**654,608**
Crude	1,325,175	1,235,516	1,096,508	596,730
Flotation	26,700	37,706	133,599	57,878
Cupreous pyrites				
0.76%–1.50% Cu	825,779	718,079	752,093	342,221
More than 1.50% Cu	81,305	115,726	127,957	83,232

* First half of year

Their production pattern was different in 1959 compared with the previous year as only 197,000 tonnes iron pyrites was produced compared with nearly 370,000 tonnes in 1958. The range available at Rio Tinto has enabled the company to mine a material of better quality in recent years so that the bulk of pyrites produced has a copper content of between 0.75% and 1%.

Tharsis Sulphur a Major Producer

The other major producing company is the Cia de Azufre y Cobre de Tharsis Limited which produced some 643,746 tonnes in 1959, an increase of 92,000 tonnes over the previous year. Of this total 553,577 tonnes were iron pyrites (440,39 tonnes in 1958) the balance being cupreous pyrites. In 1958 the company obtained over 4,000 tonnes washed pyrites.

Both of these companies' operations take place in Huelva province which accounts for about 95% of total Spanish production. In Table II it will be noted that a large number of smaller producers is shown; of these the most important are Minas de Herrerias S.A., Soc. Francesca de Piritas de Huelva and San Telmo Iberica Minera S.A.

Consumption and Exports

During 1959 deliveries were almost evenly divided between those to domestic consumers and exports, totalling 1,048,000 tonnes and 1,026,000 tonnes respectively. Domestic consumption in 1959 increased by only 4% compared with the previous year and reflected the slowing down of the rate of expansion of the sulphuric acid industry; only a very small volume of pyrites is consumed for the manufacture of sulphur dioxide used in the pulp industry. A large consumer of pyrites is elemental sulphur production which accounted for about 150,000 tonnes in 1959. The Orkla plant operated by Cia Rio Tinto at Rio Tinto, on account of increasing availability of brimstone, produced in 1959 only 32,000 tonnes brimstone, reducing its pyrites used by about 10%. Slightly lower pyrites consumption at Hinojedo where Real Cia Asturiana de Minas reduces sulphur dioxide by the ASARCO process also increased and its output of sulphur reached 8,000 tonnes in 1959.

The largest pyrites consumer in Spain is S.A. Cros which accounted for just short of one-third million tonnes in 1959, an increase of nearly 80,000 tonnes compared with the pre-

Crushing plant and headgear at Tharsis Sulphur's No. 5 shaft, Algaida

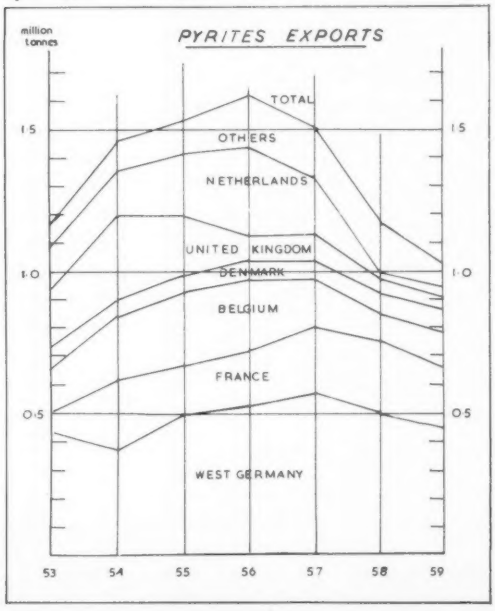
TABLE II

Spanish Pyrites Producers

	1959		1959	1958
	Iron	Cupreous	Total	Total
Cia Española de Minas de Rio Tinto, S.A. ...	197,210	596,457	793,667	922,296
Cia de Azufre y Cobre de Tharsis, Limited ...	553,577	90,169	643,746	555,275
Minas de Herrerias, S.A.	48,516	51,016	99,532	94,895
Sociedad Francesa de Piritas de Huelva	77,914	10,673	88,587	89,228
San Telmo Iberica Mineras, S.A.	40,790	31,398	72,188	83,533
Compania Nacional de Piritas, S.A.	19,090	47,074	66,164	59,289
Electrolisis del Cobre, S.A.	37,274	—	37,274	13,403
Hijos de Vazquez Lopez, S.R.C.	32,610	—	32,610	38,042
Union Española de Explosivos, S.A.	—	26,261	26,261	28,081
Cobre y Piritas de Cueva de la Mora, S.A. ...	8,749	5,296	14,045	12,503
E. Mackay Heriot-Minas San Miguel	6,127	—	6,127	14,451
Hidro Nitro Española, S.A.	4,113	—	4,113	2,612
Real Cia. Asturiana de Minas	60,659	—	60,659	70,135
The Seville Sulphur & Copper Co., Ltd.	61,697	—	61,697	45,281
Industrias Reunidas Minero Metalurgicas ...	11,346	21,706	33,052	21,640
Other Companies in Murcia Province	70,435	—	70,435	43,340
Total	**1,230,107**	**880,050**	**2,110,157**	**2,094,004**

vious year. The company operates sulphuric acid plants throughout the country and this impressive rise in pyrites consumption reflects the progressive realisation of the company's modernisation and expansion plans. The company's requirements are supplied by Rio Tinto (39%), Tharsis (37.5%) and various others (23.5%).

Union Española de Explosives also operate a network of acid plants throughout Spain, but their consumption of pyrites declined by 6% to 138,000 tonnes in 1959. With the exception of Rio Tinto, Sefanitro and Productos Quimicos Ibericos, the remaining numerous users of pyrites consume less than 35,000 tonnes annually.



The increased needs of the domestic acid industry have meant that over the past seven years the annual increase of pyrites consumption has been of the order of 7%. This contrasts strongly with exports which have fluctuated between 1.0 and 1.8 million tonnes. The sulphur crisis at the beginning of the 1950s occasioned the large rise to 1.8 million tonnes in 1952, as the result of heavy excessive purchases, in excess of prevailing consumption, by West European customers, notably Belgium, France and the United Kingdom who promoted stockpiles. However, following the increased availability of brimstone in 1954, exports of pyrites stabilised at about 1½ million tonnes for four years, only to decline to 1.2 million tonnes in 1958 and 1.0 million tonnes in 1959.

Conclusion

From the point of view of exports, the high level of plant utilisation in the major consumer countries has been to the advantage of Spain in recent months and this is expected to continue throughout Western Europe.

Following the severe curtailment of her European outlets, Spain has reversed the trend of declining exports in 1960, as a result of the high level of industrial activity and sulphur demand in West Europe. As a raw material for the sulphuric acid industry pyrites can now compete with brimstone and technical develop-

ments have strengthened this position. It is not expected that the division of Europe between the Common Market, "The Six" and European Free Trade Asociation, "The Seven," will substantially affect Spain although Portuguese and Scandinavian pyrites may receive greater official preference in the United Kingdom and Denmark. Whereas the outlook for Spanish pyrites in export markets now looks more promising, the decisive developments determining the future prosperity of the industry rest in the expansion of the home market. The establishment of a cinders treatment plant, near Santander, due on stream in the Spring of 1961, will enable the industry to obtain the full value of a small proportion of the domestic cinders output and it may be expected that similar plants, integrated on the one hand with the sulphuric acid industry and on the other with the iron and steel industry, may be added.

Difficulties in Cyprus Pyrites Industry in 1959

SHORTAGE of elemental sulphur coupled with the rapidly rising raw materials demand of Western Europe's sulphuric acid industry at the end of the last decade, provided Cyprus with a growing outlet for its large resources of pyrites. Since 1950 the level of production and exports has risen from about 600,000 tons of pyrites to over one million tons annually. In 1959 Cyprus was the second largest exporter of pyrites in the world, Spain being the largest by a small margin; nevertheless the pyrites industry faced difficulties. Competition in export markets, which intensified throughout 1958, was even stronger last year and some pyrite-producing mines in Cyprus suspended operations for a few months of the year. The strength of this competition which became evident in the previous year can be gauged when the quantity and the value of shipments of iron pyrites are compared: in 1958 the tonnage was 828,739 tons valued at £3,111,723, and in 1959 the tonnage was 657,227 valued at £1,972,197, a fall of 36.6% in value to 20.6% in volume. This was partly offset by increased exports of cupreous pyrites. Total exports in 1959 registered a slight decline (4%) compared with 1959.

Affected by low world sulphur prices

During 1959, production of pyrites which totalled 959,864 tons—made up of 238,566 tons cupreous pyrites, 208,183 tons iron pyrites, and 435,115 tons flotation pyrites—declined 4½% from 1,006,113 tons in the previous year. Flotation pyrites production increased slightly in 1959, and that of cupreous pyrites substantially, while the iron pyrites sector of the industry was noticeably disturbed, primarily by the low world sulphur prices.

There was a 7% rise in the actual tonnage of copper concentrates exported. During the year copper prices fluctuated between £215 and £267 and the average was £40 per ton higher than in 1958—the increase of 31.5% in the export value.

Cyprus Mines Corporation

Ore production from the Cyprus Mines Corporation's Mavrovouni mine totalled 829,741 dry long tons, an increase of 12,000 tons over the previous year's mining. Of this total 181,892 tons was crushed at the mill at Xeros for shipment as cupreous pyrites. Mill feed amounted to 653,199 dry long tons, a

Exports of Copper and Sulphur Materials

	1957		1958		1959		% change	
	Tons	Value £	Tons	Value £	Tons	Value £	Value	Tons
Copper concentrates	139,192	3,889,572	115,125	3,017,666	123,518	3,969,850	+31.5	+ 7.3
Cement copper ...	3,900	467,586	4,068	460,851	3,693	477,000	+ 3.5	− 9.2
Cupreous pyrites ...	226,334	1,824,987	228,821	1,492,431	300,218	1,939,872	+30.0	+31.2
Iron pyrites ...	762,501	3,379,550	828,736	3,111,723	657,277	1,972,197	−36.6	−20.6

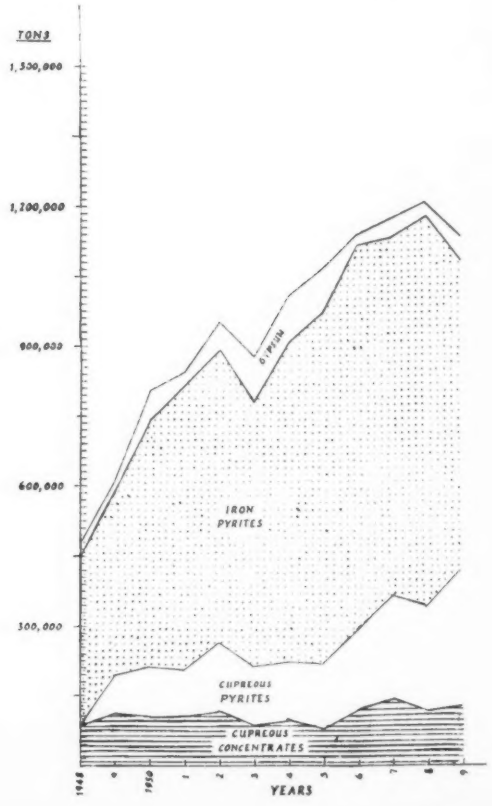
slight increase compared with 1958, averaging 3.94% copper; by flotation the following products were obtained:—

Cyprus Mines Corporation

	1958	1959	% change 1958/59
	tons		
Mavrovouni Mine			
Ore mined	817,710	829,741	+1.5
Ore treated	815,238	835,091	+2.4
Cupreous pyrites produced	193,180	181,892	−5.8
Iron pyrites produced	434,304	453,115	+4.3
Apliki Mine			
Cement copper produced	15	15	

Xeros Treatment Plant

	1958	1959	% change 1958/59
	tons		
Mill feed	622,058	653,199	+5.0
Cu content	3.84%	3.94%	
Cupreous pyrites ...	193,180	181,892	−5.8
Flotation pyrites ...	434,304	453,115	+4.3
S content	49.4%	49.9%	
Copper concentrates ...	99,978	104,669	+4.7
Cu content	19.75%	20.80%	
Copper precipitates ...	2,958	2,733	−7.6
Cu content	77%	79%	



Exports in 1959 totalled 828,703 tons of products of which 223,935 tons were cupreous pyrites and 478,922 flotation pyrites.

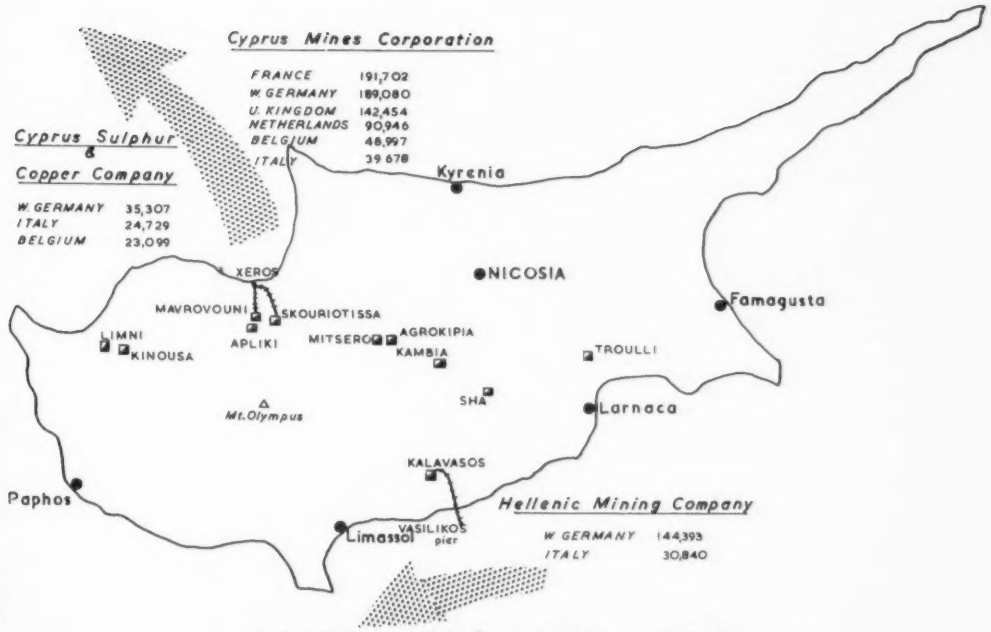
Hellenic Mining Company

Mining operations at seven of the Company's mines produced 162,040 tons of saleable iron pyrites; of this total 52.7% originated at the Kalavasos mine where additional development is under way. The Petra mine was reopened during the second half of the year and 11,309 tons of ore were mined yielding 5,518 tons of iron pyrites. A new ore body has been discovered at this mine where prospecting continues.

Mining operations at the Kokkinopezoula mine in the Mitsero-Agrokipia lease came to a standstill early in the year due to the lack of market for non-cupreous ore. Underground operations ceased when opencast workings began to affect the underground mine. The new Agrokipia Mine, where development work and prospecting is continuing both underground and on the surface, produced 9,916 tons of iron pyrites in 1959.

Hellenic Mining Company

	1958	1959	% change
Kalvasos Mine			
Ore mined	86,998	108,112	+24.3
Ore treated	137,562	193,170	+40.6
Pyrites produced ...	63,666	85,353	+34.1
Sha Mine			
Ore mined	57,542	1,508	−97.1
Ore treated	57,037	2,731	−95.2
Pyrites produced ...	23,405	1,109	−95.3
Kambia Mine			
Ore mined	136,037	53,636	−60.6
Ore treated	140,056	45,702	−67.4
Pyrites produced ...	58,029	20,407	−64.9
Kokkinopezoula Mine			
Ore mined	333,280	50,008	−84.9
Ore treated	329,042	55,246	−83.2
Pyrites produced ...	124,301	12,373	−90.0
Agrokipia Opencast Mine			
Ore mined	98,295	—	—
Ore treated	93,214	—	—
Pyrites produced ...	28,148	—	—
New Agrokipia Mine			
Ore mined	1,134	11,643	—
Ore treated	1,134	14,573	—
Pyrites produced ...	1,042	9,196	—
Mavri Sykia Mine			
Ore mined	31,571	44,022	+39.4
Ore treated	31,860	44,000	+38.0
Pyrites produced ...	22,283	28,084	+26.0
Petra Mine			
Ore mined	—	11,309	—
Ore treated	—	11,047	—
Pyrites produced ...	—	5,518	—
TOTALS			
Ore mined	748,615	280,238	−62.5
Ore treated	793,965	366,469	−53.8
Pyrites produced ...	323,544	162,040	−49.9



Destinations to which Cyprus pyrites are exported

Lack of demand for non-cupreous pyrites also affected the Kambia-Sha lease. Work was resumed towards the middle of the year and production from the Kambia and Sha mines totalled 21,516 tons pyrites.

Exports by the Hellenic Mining Company in 1959 totalled 171,990 tons iron pyrites compared with 323,379 tons in 1958, a fall of 46.7%.

Copper concentrates (20.8% copper)	104,669 tons
Flotation pyrites (49.9% sulphur) ...	453,115 tons
Leaching and precipitation yielded :—	
Copper precipitate (79% copper) ...	2,733 tons

Cyprus Sulphur and Copper Company

Production of pyrites by the Cyprus Sulphur and Copper Company originated entirely at the Kinousa opencast mine (Uncle Charles Mine) and consisted of 54,434 tons cupreous and 16,143 tons iron pyrites. The total quantity of ore mined by the company fell by 22%. Mining operations at the Limni mine, which in 1958 was inactive, produced 45,161 tons ore during the year under review.

The concentration plant treated 6,605 tons of " Uncle Charles " high grade ore during January 1959 from which 271 tons of copper concentrates, 738 tons cupreous pyrites (0.80% Cu and 49.5% S) and 4,837 tons of pyrite residues (1.18% Cu and 47.8% S) were obtained. The plant was then closed down and modifications carried out to treat the Limni slimes and Limni mine ore.

A total of 73,138 tons of cupreous pyrites was exported by Cyprus Sulphur and Copper last year as against 67,960 in 1958, a 7.7% increase. Shipments were directed to Western Germany (35,307 tons), Belgium (23,099 tons) and the balance went to Italy, which also took 14,732 tons of iron pyrites.

Cyprus Sulphur and Copper Company

	1958	1959	% change
Kinousa Opencast Mine			
Ore mined	90,580	71,214	−21.4
Ore treated	56,548	70,587	+24.8
Cupreous pyrites produced	55,085	54,434	− 1.2
Iron pyrites produced	—	16,143	—
Limni Mine			
Ore mined	—	45,161	—
Ore treated	42,000*	39,013	− 7.1

* Includes low grade ore from Kinousa Opencast, postmill slime from previous Limni operations and ore mined from Kinousa Mine.

Troulli Mining Lease

Experimental operations continued at the Troulli Mining Lease in the Kokkina area, and 60,000 cubic yards of overburden was

removed and 10,570 tons of ore mined and treated. Treatment produced 190 tons of copper concentrates (averaging 11% Cu and 43% S) and 2,240 tons of cupreous pyrites (averaging 3.44% Cu and 45.2% S).

	1957	1958	1959	%change
Ore treated ...	10,850	10,630	10,570	−0.56%
S content ...	15%	—	—	
Cupreous pyrites	670	4,000	2,240	−44%
S content ...	48%	43%	45.2%	
Cu content	3.5%	3.75%	3.44%	
Copper concentrates	832	350	190	−46%
Cu content	15.5%	15.41%	11%	
S content ...	—	—	43%	

Exports by the holders (Mr. Berdy) of Troulli Mining lease amounted to 409 tons of copper concentrates, and 3,281 tons of cupreous pyrites were sold locally.

General Position

Although the Cyprus pyrites mining industry has felt the full effects of the severe competition in the sulphur industry during the last 18 months the preliminary results for the first half of 1960 indicate a higher production rate for iron pyrites. Production for the full year is expected to be about 300,000 tons of cupreous pyrites and 800,000 tons.

During 1960 the European pyrites price has remained stable but the decline in world copper prices is expected to affect revenue adversely.

Cyprus Pyrites Exports

	First half 1959	Second half 1959	First half 1960	First half 1960 compared with First half 1959
Iron ...	376,655	280,622	413,877	−11.6%
Cupreous	256,703	43,515	145,727	+ 9.9%
	633,358	324,137	559,604	−43.2%

Cyprus has now become the second largest exporter of pyrites and her status will be enhanced when the large pyrites - based sulphuric acid plant at Pernis owned by Albatros Superfosfaatfabrieken N.V. and Cyprus Mines Corporation comes into operation in 1961; this will be based on cupreous pyrites.

Demand for pyrites in France has so far been unaffected by indigenous brimstone supplies and many sulphuric acid producers using pyrites are renewing their plants in slow stages. Also, in view of the high level of French acid production, pyrites imports, notably those from Cyprus, are expected to rise next year.

New Sulphonation Process Developed in Israel

A NEW detergent manufacturing process which cuts production costs by two-thirds has been developed in Israel. Importance of the process lies in the fact that it makes a detergent factory completely independent of sulphuric acid or oleum, produces better products and cheaper raw materials for sulphonation.

A. Davidson, Zohar Soap and Detergent Works, Kubbutz Dalia, Israel, worked out the process, which is based on the use of gaseous SO_3. The exact amount of molten sulphur is transformed into dilute SO_3 which is cooled and used for direct sulphonation of detergent alkylate, fatty alcohols, etc.

Process Data

To sulphonate 100 parts of detergent alkylate (dodecyl benzene) by the conventional sulphation process 150-160 parts of sulphuric acid or 105-110 parts of oleum (20-30% free SO_3) are used. Using vapourized liquid SO_3 — normally an expensive and difficult raw material to handle — 35 parts are used. The new process requires 14-16 parts of high-purity (technical grade sulphur). Although this represents the sulphur equivalent of 35 parts of SO_3, its use in this form eliminates the need for the conventional process stage and plant for sulphuric acid and SO_3 production.

A special feature of the Israeli process is that only the material for sulphonation and the molten sulphur are reacted, and the product produced is the sulphonated material without by-products, notably spent acid.

Sulphonation is carried out with small quantities of SO_3 in a practically inert carrier gas, to prevent any undesirable oxidation side reaction.

Patent rights have already been sold to Colgate-Palmolive Ltd., New York, U.S.A., and other U.S. companies.

Prices and Trends

Signs of Stability in World Sulphur Prices

WORLD sulphur prices are showing signs of stabilising. For the first time after three years' progressive price slides and cuts a measure of stability appears to have entered markets, including those where competition had been fiercest. The first indication—in mid-October—came none too soon. As highlighted in "Sulphur" No. 30 (September 1960) the almost indiscriminate pursuit by the major brimstone producers of tonnage sales, whatever their size, by the inducement of price cuts or overt and hidden discounts had developed into a real threat to the continued ability of the sulphur industry, as it is constituted to-day, to provide long-term continuity of supply under balanced market conditions. The principal sufferers, the smaller producers, were facing ruin and the impact of the continuous erosion of the price basis, as established by the Frasch sulphur producers, threatened not only suppliers of other forms of sulphur, notably pyrites, but what was more serious, removed the incentive and jeopardised the ability of all potential suppliers, to develop new sources of supply.

Firmer Prices for 1961

Market and price leadership, which has been so noticeably lacking these past three to four years, is now, if not re-established, at least in the making. The first indications of firmer prices came from Europe where Soc. Nationale des Petroles d'Aquitaine's recovered sulphur is becoming the principal source of brimstone supply. The company's attitude favouring firm prices is undoubtedly a major factor in setting the tone of the markets. SNPA, since its entry into the sulphur market in 1958, has pursued a policy of selling at delivered prices virtually identical with those of its Frasch sulphur competitors in an endeavour to obtain the highest possible sulphur revenue compatible with competitive market conditions. SULEXCO, the joint export sales organisation of the U.S. Frasch sulphur producers, has in a number of European countries indicated firmer prices for 1961 and their policy in this major sector of the world sulphur market is indicative of the efforts of the principal world suppliers of brimstone towards greater price stability.

To the lesser of the two Mexican Frasch sulphur producers, Gulf Sulphur Corporation, the prospect of stable prices offers the first ray of hope of averting imminent bankruptcy whereas Pan American Sulphur Company, established as a world supplier with a large stake in the U.S. market and enjoying economic conditions of primary sulphur production probably unsurpassed by any other company possibly with the sole exception of Texas Gulf's Boyling Dome, welcomes the development as it seems to portend that instead of being seen as a newcomer, if not an intruder, into world markets, the company will now be able to pursue the marketing policies which reflect its responsibility and importance among the major sulphur producers.

Price Basis

The effect on world prices has been greater in principle than in reality. Offers equivalent to $18 per ton f.o.b. Gulf ports have disappeared and the expectation of some of the buyers in the more competitive markets to receive offers for 1961 at similar prices have been disappointed. On balance the price level that emerges is at $21-22 per ton f.o.b. Gulf equivalent, which for the majority of markets represents little if no increase. This price level is thought to be still too low not only in relation to commodity prices as a whole and to the increased cost of sulphur production, but mainly because the profit margins are generally too slender to encourage the new developments on which the future stability of sulphur markets depends. It is debatable whether the desirable price basis is $2 or $5 above the present one. Two salient principles, however, emerge. It would be folly and an unwarranted display of strength if the producers, now that they have

abandoned indiscriminate price-cutting competition, were to go to the other extreme and by successive leapfrogging increases drive up the world price to unrealistic levels. Their aim must be to establish the lowest price, compatible with meeting the claims of new developments and also resulting in reasonable profits, and to maintain it. Stability of price coupled with long-term security of supply are the prime requirements of the sulphur consumers. This duty to the industry must be recognised by the sulphur producers. Indeed, in the light of their objective to expand the uses of sulphur and seeing that despite the growing number of sulphur users, notably in the sulphuric acid industries of the world, the sulphur industry is still narrowly based, this conclusion is inescapable.

Sulphur Consumers' Responsibilities

The other principle that emerges is the need for a responsible attitude on the part of sulphur consumers. If, as can be expected, their legitimate needs are met by the sulphur producers they will collectively and severally have to curb their endeavours to obtain price advantages in relation to fellow consumers, even though these may be their competitors in chemical intermediary and end products, and cease to play off one producer against another by repeatedly changing their purchasing policies. In fact such a positive attitude has been shown for many years to mutual advantage by the majority of pyrites consumers of Western Europe, and also by the brimstone consumers of Japan and by a few major brimstone purchasers in the U.S.A., the U.K. and Europe.

Transport Costs

Improved relations and better understanding within the sulphur industry should not impair, let alone stifle, competition, which from the consumers' viewpoint should centre on better consumer service in terms of quality of product, technical services and above all, reduction of transport costs. The incidence of ocean freights on the delivered cost of sulphur is unquestionably the most unstable of the various factors and this in turn profoundly affects any country's or company's purchasing policy and pattern.

U.S. Sulphur Production Problems

At the same time it must be recognised that in the short term the industry faces grave difficulties in its endeavours to promote greater stability. The industrial recession in the U.S.A. and a number of major European economies is not as yet balanced by advances in underdeveloped countries whose need in the not too distant future should make a substantial impact on the availability of world commodity resources, notably sulphur. Sulphur production capacity exceeds the level of demand by 4-4½ million tons and the rapid expansion of Canada's sulphur recovery potential and output will not only increase the overall margin but tend to affect what has become one of the more sensitive sulphur markets, the U.S.A. Representing the natural outlet for a large proportion of Mexican Frasch sulphur, coupled with increasing domestic recovered sulphur supplies, the U.S. sulphur market is such that the domestic Frasch sulphur producers are confronted with the need to limit their output severely and the annual level of domestic Frasch sulphur sales of about 3½ million tons per year is unlikely to be exceeded for at least three to five years. The existing surplus capacity at old domes and especially at Freeport's new projects, Grand Isle and Lake Pelto, the latter on stream four weeks ago, will demand the highest measure of restraint and leadership if a stable sulphur market is to be created and preserved. A small measure of relief is the imminent closure of Jefferson Lake Sulphur Company's Starks and Clemens domes, both small producers who are approaching the European pyrites industry, whose contribution to primary world sulphur supplies is second only to Frasch sulphur, also responded to the new tone in markets and, abandoning considerations of further reductions which had been strongly raised six months ago, when world sulphur prices started sliding again, will maintain its price level—based on 60s. per tonne f.o.b. Huelva—for the first half of 1961. Technical improvements to roasters coupled with continued satisfactory returns on metal values in pyrites residues, notably iron, have re-established—albeit more selectively—the status of pyrites in the European sulphur consumption pattern.

This improving balance between supplies of various forms of sulphur gives the best safeguard of consumers' interests. The events of the past three months have set a new tone which, while demanding higher standards, proof against impartial criticism, deserves the watchful support of the whole industry.

PRICES

Brimstone

U.S.A. Posted prices remain unchanged at $25 per ton f.o.b. for Gulf Ports for bright sulphur with discounts of $1 per ton off-colour supplies and $1.50 for delivery f.o.f. ex mine. Posted prices apply only in a small number of protected markets and the bulk of domestic and export sales is based on "delivered prices," which include freight contributions and discounts of up to $3.50 per ton. The bulk of U.S. Frasch sulphur is currently priced at f.o.b. equivalent of $21-22 for bright and $20-21 for off-colour materials. The trend is for the most recent quotations to be higher. The introduction of liquid sulphur shipments in tankers along the Atlantic East Coast will tend to raise the effective f.o.b. price as the current cost of transport in U.S. flag tramps is appreciably higher than the anticipated cost of tanker shipments.

Delivered prices in Florida (Tampa region) remain unchanged at $25 per ton for liquid off-colour sulphur as supplied by U.S. producers, notably Texas Gulf Sulphur Company, and also for imported Mexican acid treated bright and off-colour sulphur. Delivered prices in the Northern Central and Great Lakes area have remained unchanged at $26-27, while along the Atlantic east coast delivered prices, hitherto at $27.50, have firmed following increases by Pan-American Sulphur Company.

Mexico. Following the announcement in mid-December by Pan-American Sulphur Company raising effective f.o.b. prices by $2 per ton, these now correspond to listed prices of $23.50 per ton of acid treated yellow sulphur f.o.b. Coatzacoalcos and $21.50 for off-colour grades. Domestic prices in Mexico remain unchanged at Pesos 280 ($22.40) per tonne for Frasch sulphur and recovered sulphur delivered to the sulphuric acid industry and Pesos 350 ($28) per tonne to non-acid users. Sulphur refined from native ores commands a price of Pesos 395 ($32.60) per tonne on account of freight differentials.

Export Prices

In European markets delivered prices of U.S. and Mexican sulphur and French recovered sulphur range from $26.50 to $31. Recent offers by all producers have tended to be $1-1.50 higher than obtained in the most competitive markets, notably the Low Countries, and in general forward prices have been higher than buyers had expected. Delivered prices to India have also firmed and most offers are around $30 at Bombay and $31 at Calcutta.

Russian sulphur continues to be offered in increasing quantities at competitive prices of up to $2 below corresponding delivered prices of Frasch sulphur or French recovered sulphur. Substantial offers are being made to Sweden at up to S.K. 10 below corresponding import prices of S.K. 158.

Recovered Sulphur

As the result of the firmer tone of offers by the major sulphur suppliers the decline of indigenous recovered sulphur prices has been halted. In Western Germany prices in the Ruhr and at Hamburg of domestic brimstone recovered at oil refineries and by Ruhrgas range from DM118-125 plus turnover tax, handling and service charges.

Recovered sulphur in Belgium is sold at B. Francs 125-135 per tonne, and in Holland D.Fl.95-100. In France delivered prices to domestic consumers range from Frs.13,000-14,000 per tonne.

In Sweden domestic supplies by Svenska Skiflerolje A.B. are sold at S.K.158 and imports of Orkla sulphur are priced similarly.

Recovered sulphur prices in Western Canada remain based on $23.50 per ton **ex** plant. Delivered prices, incorporating freight charges, are subject to wide fluctuations in view of the large area of the market which extends throughout Alberta, British Columbia, and the U.S. North West Pacific states. As yet no reductions of the rail tariff have been secured by suppliers and the high cost of rail freight from recovery plants to the principal consumer market in the Great Lakes area still gives Frasch sulphur a freight advantage of up to $10 per ton. Exports from Vancouver are

expected to be based on prices corresponding to those of Frasch sulphur from the Gulf.

Pyrites

As the result of firmer brimstone prices, the necessity to lower pyrites prices to maintain differentials has been avoided and the level of European pyrites prices is to remain unchanged during the first half of 1961. Rio Tinto and Tharsis crude fines pyrites are sold at 60s. per ton f.o.b. Huelva basis 48% sulphur and other Spanish pyrites are priced correspondingly within narrow limits. The differential for Rio Tinto "confines" gravity concentrates remains unchanged at 10s. per tonne less. Portuguese pyrites are also based on 60s. per ton f.o.b. Setubal and Norwegian and Cypriot pyrites are priced competitively. The current price of Bolidens pyrites in Sweden of S.K.54-50 per tonne f.o.b. may increase. In view of the continued weakness of copper prices future returns of cupreous residues will be adversely affected and their aggregate value is likely to decline to about 75s. per ton. No significant change is expected in the valuation of the iron content. Non-cupreous residues are valued at 70s. per tonne free Ruhr, with best qualities at about 5s. more.

SUPPLY

Brimstone

Production of Frasch sulphur in the U.S.A. has been maintained at a level of just over 400,000 tons per month. Output in 1960 is expected to be just under 5 million tons, about 10% more than last year, although deliveries to domestic consumers are likely to be limited to 3.4 million tons on account of increased deliveries of domestic and Canadian recovered sulphur and imports of Mexican Frasch sulphur. Producers' stocks, notably those of Texas Gulf Sulphur Company, will have been lowered by some 230,000 tons during the year.

The start of operations at Freeport's Lake Pelto increased available capacity and may have to be compensated by further reductions of production rates at other domes, which are estimated at about 55% of installed capacity.

U.S. Frasch sulphur exports in 1960 are expected to total 1.7 million tons, the highest on record.

Mexico

Total production in 1960 is expected to reach 1.2 million tons, mainly as a result of the high level of production of Pan American Sulphur Company, expected to account for at least one million tons. Gulf Sulphur Corporation's output is now unlikely to exceed 200,000 tons although by substantial reduction of stocks the company has expectations of shipping about 250,000 tons this year. Recovered and refined sulphur productions wholly destined for the home market are expected to total about 110,000 tons during 1960. Mexican sulphur exports have been maintained at a high level and are expected to total 1.2 million tons in 1960, of which about one-half is destined for the U.S.A.

South America

In Argentina the Government-owned Casualidad Sulphur Mine in Salta is to be replanned and modernised by Japanese experts and its production increased by two-thirds to 30,000 tons p.a.

Brazil, whose mounting brimstone requirements are met wholly by imports, is intensifying geological search for elemental sulphur. Occurrences of ore near Canavieiras in Bahia State are being investigated.

U.S.S.R.

The deliveries of Russian sulphur which have reached consumers in Western Europe have been identified as at least in part of native ore origin as the ash has been found to contain calcium sulphate. The strong petroleum smell of the material has given rise to the belief that it may have been recovered at oil refineries but the possibility cannot be excluded that ore refining using a petroleum fraction as solvent may be employed.

Poland

Output of refined sulphur at the Piaszeczno mine in Eastern Poland is expected to total 60,000 tons this year whereas the programme for 1961 based on an ore production of 950,000 tons is likely to produce about three times this year's output.

RECOVERED SULPHUR

U.S.A.

Output of recovered sulphur during the closing months of the year has been maintained at over 60,000 tons per month and deliveries to U.S. customers are expected to exceed 700,000 tons in 1960.

Canada

The current rate of production has risen and it is expected that in 1960 a total of 520,000 tons sulphur will be produced. Shell Oil Company of Canada will install a 1,000 tons per day sulphur recovery plant at Pincher Creek at a cost of $20 million. Texas Gulf Sulphur Company has acquired a number of important gas leases in the Panther River area where there are a large number of gas wells with high—up to 85%—concentrations of H_2S.

Important plans have been announced by a number of gas and oil companies which underline the anticipated rapid increase of recovered sulphur output by the end of next year and in 1962. During the period January to September 1960 production in Alberta totalled 264,098 tons, the monthly output in September having risen to 26,238 short tons. In British Columbia production to the end of July totalled 97,131 short tons.

Lacq

Construction of the last stage of the gas-cleaning and sulphur recovery plant is due to be completed in January 1961, when production will rise from the current level of 3,000 tons to 4,000 tons per day. During 1960 exports from France are expected to reach 400,000 tons and domestic deliveries about 300,000 tons. As the result of a heavy delivery programme end-year stocks are unlikely to exceed 130,000 tons.

PYRITES

Demand from sulphuric acid industries in the U.K. and North Western Europe continues to make strong calls on European pyrites suppliers. In Scandinavia expansion of sulphite pulp production by some 8 to 10% is similarly raising the level of pyrites deliveries.

Exports of pyrites from Cyprus are expected to exceed one million tons, mainly as the result of substantially increased deliveries by the Hellenic Mining Company which, after severe reduction of production and exports in 1959, is expected to ship about one-quarter million tons this year.

Spanish pyrites exports are once more expected to be the world's largest at about 1.2 million tons. Apart from higher exports by the two leading producers, Cia. Rio Tinto and the Tharsis Copper and Sulphur Company, many of the smaller mines have raised production and exports. Among new markets for Spain is Egypt, which is being supplied mainly from the mines near Cartagena.

The only new pyrites project reported recently is that of Foldallwerk A.S. in Central Norway, where the company is speeding work to complete the new mine's headframe and buildings before the winter.

Freight Charterings and Rates

The late autumn and the early winter months of 1960 produced little out of the ordinary in charterings for sulphur and pyrites. In August/September heavy bookings for Frasch sulphur were made by British and near Continental importers at around 47s. 6d. and $5 a ton respectively for U.S. Gulf/Coatzacoalcos loadings. By taking advantage of the pronounced dip in freights at that time those receivers certainly saved themselves at least $1 a ton in the light of present markets. During the same period Australian buyers secured freight from the Gulf at only 78s. 9d. a ton on gross terms (shipowner to pay costs of loading and discharging) for a 12,000-tonner. Reported bookings from Bayonne have been negligible, but it is known that a number of coasters have been fixed to United Kingdom destinations.

The news that an American turbo-electric tanker of 16,000 tons (one of the war-built T-2 type) is being converted by the Bethlehem Steel Company into a molten sulphur carrier and that a second "conversion" has been decided on by other producers, has as yet caused little comment on this side of the Atlantic. One would have expected some positive reaction as the project has important implications. If the technical problems of transporting the element in liquid form over the 2,000 miles from the Gulf to North Atlantic ports (for which the tankers are being adapted) have been mastered, this would resolve

some of the major impediments in respect of shipments over the 5,000 miles or so to British and North European ports. Not resolved for lack of experience would be problems of bulk storage, possibly over long periods. Capital costs might be high in respect of insulated and heated tankage at discharging berths, but handling charges would be negligible. Molten sulphur could be put ashore by the ship's own pumps and reloaded for distribution as required, by gravity, into coiled lighters or road or rail-cars. Recent research has highlighted the extremely high cost of dock, labour and inland transport charges involved in handling and distributing sulphur in the dry state. It might be that delivery in liquid form would give lower delivered costs at users' works. The risk of contamination would be avoided and present wastage due to losses of cargo carried away by the wind would be eliminated.

Pyrites charterings remain unspectacular although steady trade continues at freights which show little fluctuation to Continental ports, and to a lesser extent the United Kingdom, from Cyprus, Spain and Portugal. Further trade is reported from Kotka (Finland) to Rotterdam at DM 11 a ton f.i.o. and several ships have been done from Carthagena to Alexandria at around the 21s. 6d. mark, mostly for part-cargoes of about 50,000 tons combined with an equal quantity of superphosphate in the same direction.

Active steel production leads to a continuing heavy call for burnt ore carriers, mainly from the Mediterranean. Recent fixtures include the payment of 24s. 0d. a ton from Savona to Barrow and sixpence less for Rotterdam discharging. Various small lots have been booked from Norwegian ports to North Germany at from Nor. Kr. 16½ to N. Kr. 18 a ton f.i.o. Newcastle (N.S.W.) shippers offer $5 a ton for 13,000 tons of residues to 1 port Japan.

Of more interest perhaps than reports of business done are present indications of shippers who seek tonnage. From the Gulf/Coatzacoalcos to Antwerp/Hamburg freight cover is sought for 140,000 tons of sulphur over the next 12 months and contracts for 60,000 tons are offering from the same area to Sorel and to the U.S. Atlantic. Pyrites charterers will look at freight offers for the first half of 1960 from Setubal to Belgium, also from Huelva and from Morphou Bay to Priolo or Syracuse. Such keenness to operate ahead can but mean that operators prefer to "hedge" against freight increases. In this they are probably right, as the general freight situation is firmer than for three years and the margin of laid-up tonnage in the smaller sizes is slender. It seems probable that charterers will have to be a little more generous than at present in order to persuade shipowners to engage themselves for forward loadings.

The following freight statistics are based on known charterings, save where recent reports are lacking. In such cases "notional" figures, calculated on freights paid for other commodities moving in the same direction, are inserted:—

EXPORTING AREA	DESTINATION	FREIGHTS PER TON		
		To-day	Year ago	End 1958
U.S. Gulf/Mexico	United Kingdom[1]	52s. 6d.	52s. 6d.	48s. 0d.
,,	N.W. Europe[2]	$5.90	$6.00	$4.50
,,	India[3]	$10.60	$10.15	$9.00
,,	Australasia[3]	$11.35	$11.15	$10.85
,,	Brazil[4]	$5.25	$5.50	$5.00
Bayonne	N.W. Europe[4]	21s. 6d.	22s. 0d.	17s. 6d.
,,	United Kingdom[1]	31s. 0d.	36s. 0d.	22s. 3d.
Huelva	Antwerp[5]	25s. 0d.	28s. 0d.	23s. 9d.
Cyprus	Rotterdam[5]	25s. 0d.	27s. 6d.	28s. 0d.
,,	United Kingdom[6]	36s. 6d.	45s. 0d.	38s. 6d.

[1] Cargo f.o.b., ship to pay current rate for discharging.
[2] Shipowner to pay 50 cents ton for loading and 40 cents discharge.
[3] Ship pays 50 cents ton loading and current rate discharging.
[4] Cargo f.i.o. (no charge to ship for loading/discharging).
[5] Ship pays 2s. 6d. ton loading and 2s. 6d. ton discharge.
[6] Ship pays 2s. 6d. ton loading and current rate discharge.

U.S. Frasch Sulphur Production Expected to be 10% up in 1960

And Export Sales expected to reach new Record Level

At the present time U.S. economy is in a state of delicate balance, and during the last few months the slide on U.S. domestic business has continued. Unemployment has already risen to about 7% of the labour force and may reach a post-war record when the November figures are published. Opinion is divided on the question of whether the bottom of the present U.S. recession has been reached and all the available evidence to date points to a general lack of buoyancy. It is suggested, however, that some improvement in the present situation will be seen in 1961.

Surveying the results of the sulphur and sulphuric acid industry during the first eight months of this year compared with the same period in 1959 it is noted that while production has increased 14.8% to 3,288,488 tons, apparent consumption has declined 251,017 tons (7.5%), that Frasch sulphur sales have remained virtually static (an 0.07% increase) and that total stocks have decreased by 5.2% to 3,822,392 tons.

Use of sulphur has decreased during the past six months due partly to seasonal factors and also to the fall in U.S. industrial activity. In particular, lower consumption of sulphuric acid, carbon disulphide and insecticides has been reported. While there are hopes that the decline noted above may be halted during the next month or two, the view is held by several trade sources that autumn and winter totals may not reach those of 1957 although they will exceed 1959 levels.

Frasch Sulphur

Production. During the period January to August 1960, production of Frasch sulphur amounted to 3,303,605 tons, a significant increase of 451,500 tons (15.8%), compared with the corresponding period of 1959. Output continues to be restricted by U.S. producers, although this year they are operating their mines more in line with demand than in 1959. Total output in 1960 is expected to be about 5 million tons Frasch sulphur, an increase of 10% over the preceding year.

Apparent Sales. Apparent sales of Frasch sulphur during January to August 1960 amounted to 3,420,116 tons, almost identical with last year's level of 3,417,653 tons. Whereas exports showed a significant rise (13%), domestic deliveries of U.S. Frasch sulphur are 5.5% lower than in the same period of 1959.

Stocks. Frasch sulphur stocks at the end of August 1960 totalled 3,718,759 tons, a decrease of 157,033 tons (4%) compared with the same time last year. The bulk of the decrease is attributable to Texas Gulf Sulphur Company's continuing with its programme of converting stocks into cash. The decline in producers' stocks for the whole year is expected to be about 250,000 tons as against 635,000 tons in 1959.

During 1960 Freeport Sulphur Company have brought two new sulphur properties into operation—the major Grand Isle offshore mine in April and the smaller Lake Pelto property in November. U.S. Sulphur Company began operations at its small High Island mine in November.

Recovered Sulphur

Production of recovered sulphur in the first eight months of 1960 has continued to expand, and has reached a total of 474,590 tons, an increase of 8.5%, compared with the same period in 1959, when 437,409 tons was produced.

Apparent sales of recovered sulphur in the period January to August 1960 have also shown a significant increase having risen to 511,223 tons, 11.5% more than in the same period of 1959 when sales amounted to 458,614 tons.

It is expected that for 1960 domestic recovered sulphur sales will exceed production by 35,000 tons despite the increased output of over 700,000 tons. During this year, six new sulphur recovery plants representing some

125,000 tons of annual capacity came on stream in South-Western United States.

Trade

Imports of sulphur by the United States during the period January to August 1960 amounted to 525,157 tons compared with 457,827 tons in the corresponding period of last year, an increase of 14.7%. For the whole year imports are expected to total 760,000 tons. Of these Canadian sulphur is likely to account for 150,000 tons, of which 60,000 tons are estimated to come from Texas Gulf's and Jefferson Lake's plants in Western Canada and replace tonnage they would normally ship from their Frasch properties.

Pan American Sulphur Company is reported to have increased its stockpile in Tampa and it is estimated that imports from Mexico will probably amount to 610,000 tons for 1960 or 20,000 tons more than actual deliveries to U.S. customers, and slightly below 1959 imports.

In contrast to the decline in Frasch sales in the United States, export sales of the Frasch producers for the year are expected to be about 90,000 tons higher and will represent a new record level of 1,700,000 tons.

In the period January to August total exports amounted to 1,173,288 tons, a 13% increase compared with the same period in 1959.

The gain in exports has been achieved despite higher Mexican overseas shipments—expected to be 200,000 tons greater in 1960 than in the previous year—increased sales of Lacq sulphur—300,000 tons higher—and greater production from indigenous sources—100,000 tons higher—in importing countries.

World demand for elemental sulphur is at a new peak level, about 20% higher than in 1959.

The importance of Western Europe as an export market for U.S. sulphur is shown by the distribution of export destinations:—

	1959	1960	
	Tons		
Austria	2,000	4,170	+ 2,170
Belgium	41,700	56,859	+ 15,159
Denmark	1,000	—	− 1,000
France	62,995	39,210	− 23,785
Germany, West ...	52,140	58,381	+ 6,241
Netherlands ...	24,800	54,604	+ 29,804
Norway	—	835	+ 835
Spain	—	2,935	+ 2,953
Sweden	3,200	6,550	+ 3,350
Switzerland	24,900	30,420	+ 5,520
United Kingdom ...	174,605	219,509	+ 44,904
Total	**387,340**	**471,381**	**+110,936**

With the exception of France and Denmark the countries of Western Europe have all increased their imports substantially.

Consumption

From the results for the first eight months, and forecasts for the rest of the year, it is estimated that U.S. sulphur consumption in 1960 will amount to 6,050,000 tons and hence will establish a new record peak for the second consecutive year. Consumption, however, is expected to be only 100,000 tons or 2% above that of 1959, compared with the increase of 600,000 tons or 11% rise between 1958 and 1959. This lower increase for 1960 is in line with the recessionary trends noted in general business, which measured by the F.R.B. Index of Industrial Production, is expected to rise only 3% as against the gain of 13% in 1959.

The increase in U.S. sulphur consumption has not been shared equally by all forms of sulphur. Elemental sulphur has accounted for about one-third of the total increase and the increase is entirely recovered sulphur. Both

Comparison of	Jan./Aug. 1959	Jan./Aug. 1960	% Change
Total Production	**3,288,488**	**3,778,195**	**+14.8**
Frasch	2,852,079	3,303,605	+15.8
Recovered	437,409	474,590	+ 8.5
Apparent Consumption			
Total	**3,295,852**	**3,047,835**	**− 7.5**
Apparent Sales			
Frasch	3,417,653	3,420,116	+ 0.07
Recovered	458,614	511,223	+11.5
Total Stocks	**4,032,134**	**3,822,372**	**− 5.2**
Frasch	3,875,792	3,718,759	− 4.0
Recovered	156,342	103,613	−33.7
Total Imports	**457,827**	**525,157**	**+14.7**
Total Exports	**1,037,966**	**1,173,288**	**+13.0**

domestic material and imports from Western Canada have risen but consumption of Frasch sulphur declined (− 7.5%).

Increase in sulphur consumption in 1960 is entirely in the acid-consuming sector of the markets. Non-acid consumption remains unchanged as the rayon industry's difficulties due to low prices, stiffer competition from the new synthetic fibres and depressed earnings offset the effect of higher consumption of sulphur by the pulp industry.

In January and February 1960 apparent domestic sulphur consumption was lower than in 1959. Following the upturn in trade in the spring, however, consumption slightly exceeded that in the same period of 1959, but by the summer had dropped to the 1959 level.

The excessive drop in consumption in mid-1959 was due to the steel strike, but the drop this year is attributable both to the low utilisation of steel capacity (50%) and the low level of car production.

Brimstone for acid consumption increased slightly in the period under review but that for non-acid use is estimated to have declined by about 15%, the principal decline occurring after June; this is related to difficulties in the rayon and rubber industries associated with the drop in car production and in the case of the former in the advance in the use of synthetic fibres. The cellulose film industry, however, remains an important sulphur consumer.

Preliminary data for carbon disulphide production for the first half of 1960 shows a decline of 7% at 260,000 tons.

In 1959, U.S. consumers are believed to have increased stocks by 20,000 tons, but this year it is expected that 30,000 tons will be withdrawn from stock. This would contribute to the reduced level of sales of U.S. Frasch sulphur.

Of the consuming industries, single superphosphate, synthetic ammonium sulphate and rayon manufacturers were affected more adversely than others.

Sulphuric Acid

Production of sulphuric acid in the first eight months of 1960 rose to 12,096,750 short tons (100% H_2SO_4) compared with 11,770,061 short tons in the corresponding period of 1959, representing a rise of 2.8%, although production in June and July was at its lowest level for the period.

Output and use are expected to increase, however, in the last months of the year so that total output may reach 19 million short tons on a gross basis as compared with 17.6 million short tons in 1959. Virgin sulphuric acid production this year is expected to be at a new record level of 17.2 million short tons as against the previous peak of 16.9 million short tons in 1959.

Spent acid production has shown a significant increase and in the first eight months of this year amounted to 520,492 short tons, a 13.4% increase over the same period in 1959.

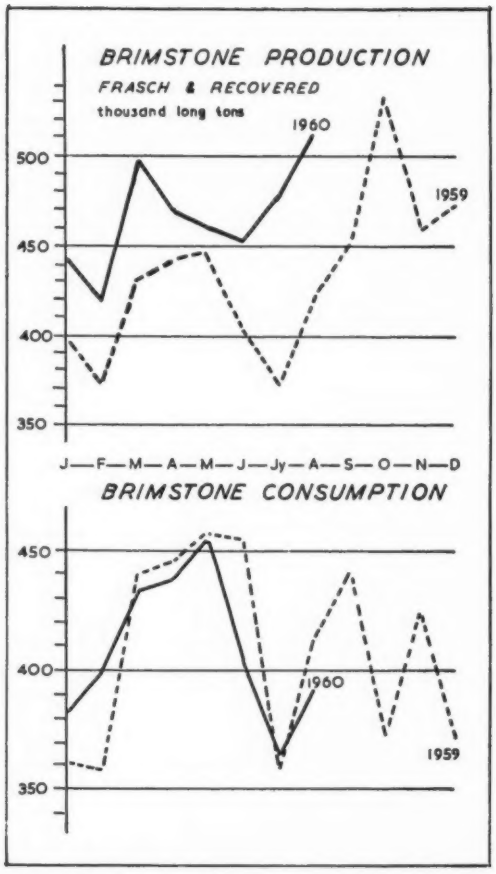
Output of by-product sulphuric acid this year has shown a marked increase as in 1959 results were affected by the copper strike. Recovery has been less than it might have been, however, as there has been a long strike this year at two major lead and zinc smelters.

Consumption of acid by the U.S. fertilizer industry is expected to be 2% higher this

SULPHURIC ACID PRODUCTION

Totals	Jan./Aug. 1959	Jan./Aug. 1960		% Change
Total	**11,770,061**	**12,096,720**	**+326,659**	**+ 2.8**
Chamber Process	1,377,157	1,315,038	− 62,119	− 4.5
Contact Process	10,392,904	10,781,682	+388,778	+ 3.7
Spent Acid	**458,827**	**520,492**	**+ 61,665**	**+13.4**
New Acid Total	**11,311,234**	**11,576,228**	**+264,994**	**+ 2.3**
Chamber	1,377,157	1,315,038	− 62,119	− 4.5
Contact	9,934,077	10,261,190	+327,113	+ 3.3
Oleum	1,112,466	1,188,447	+ 75,981	+ 6.8
Other than oleum	9,280,438	9,593,235	+312,797	+ 3.4

Comparison of	June 1959	July 1959	August	June 1960	July 1960	August
Gross Total	**1,469,489**	**1,365,098**	**1,310,875**	**1,495,438**	**1,336,027**	**1,403,831**
Chamber	166,962	132,803	120,864	149,888	116,672	105,694
Contact	1,302,527	1,232,295	1,190,011	1,345,550	1,219,355	1,298,137
Spent Acid	146,490	134,603	143,764	155,292	137,466	147,653



year, which is a substantially smaller increase for 1959 when requirements by this industry increased 8%.

The changeover from normal superphosphate to the more concentrated forms of phosphate fertilizers has continued; acid consumed in triple superphosphate and ammonium phosphates was 12% higher while consumption in normal superphosphates declined by 7%.

There has been a curtailment of acid requirements for synthetic ammonium sulphate production of 18.5%, while the low level of operations of the steel industry has increased acid requirements for by-product ammonium sulphate by 1.5%. This means that total sulphuric acid requirements for ammonium sulphate production have fallen by 10.7%.

Consumption of sulphuric acid in the chemical and industrial markets is expected to show an increase of 3% for the year in line with the increase in overall industrial activity. This compares with a gain of 12% in 1959. All of the acid consuming industries in this sector, with the exception of rayon and to a lesser extent of titanium pigment, have been operating above last year's levels.

Shortage of by-product acid developed in the western mining area, but the uranium industry was not affected as sulphuric acid was available in greater quantities from the two new plants—J. R. Simplots' new 400 ton per day plant at Pocatello, Idaho, and Eusquehanna—Western's 100-ton-per-day expansion at Riverton, Wyoming.

Outlook

Affecting the sulphuric acid industry at present is the lower industrial production, such as in steel, motor cars, chemical uses and rayon which has caused a decline. Greater sales of acid for fertilizer use, hydrofluoric acid, aluminium sulphate, steel pickling, petroleum uses, pigments, detergents, cellulose films and rayon are expected. Although the rayon industry's consumption was behind that of 1959, the rayon tyre cord manufacturers have been successful in signing up the car manufacturers for a further year to supply rayon cord for most of the tyres to be sold on new 1961 models. At the same time the nylon producers are confidently building new capacity in anticipation of obtaining this market in 1962. Much of the new nylon capacity is based fortunately on caprolactam and most of this material is made by a sulphur-using process.

Sulphuric acid will be used in the manufacture of nylon-6 at E. I. Du Pont de Nemours and Company's new plant to be built near Houston, Texas. The 1,000 ton per day acid plant due on stream shortly will include sludge acid facilities to handle waste acid from nearby refineries.

Also requiring sulphuric acid will be phosphoric acid manufacture by the two new plants to be built in Illinois. The General Chemical Division of Allied Chemical Corporation has announced plans for a 50,000 ton per year phosphoric acid unit to be built near its sulphuric acid plant in East St. Louis; and National Phosphate Company has announced

plans for a 100,000 ton per year unit to be located at Marseilles, about 75 miles from Chicago. Both companies have reported that their phosphoric acid would be used for the manufacture of fertilizers.

American Cyanamid is to double phosphoric acid capacity to 400,000 tons a year at Brewster, Florida, by October 1961; Valley Nitrogen Producers has started up a plant with capacity for 16,500 tons per year of wet phosphoric acid; Virginia-Carolina Chemical will install a new phosphate rock flotation unit; Bunker Hill Chemical completed in September a 130 ton per day phosphoric acid plant at Kellogg, Idaho; Swift and Company is to double wet-process phosphoric acid capacity at two Florida plants to 175,000 tons annually, completion being set for May 1961; San Francisco Chemical, jointly owned by Stauffer Chemical and Mountain Copper, will build a 200,000 ton per year phosphate mill near Vernal, Utah; Olin Mathieson is increasing phosphoric acid production; and U.S. Phosphoric Division of Tennessee Corporation is expanding phosphate processing facilities by 50%, completion date being late 1961 or early 1962.

Several new aluminium sulphate plants have recently come on stream in the U.S. Stauffer Chemical's new plant at Vernon, California, is its fourth on the West Coast, and at Connce, Tennessee, the company is building a liquid aluminium sulphate plant scheduled to be on stream about February 1961. At El Legundo, Allied Chemical has its fifth in that area. An interesting new aluminium sulphate plant is to be built by North American Coal Corporation at Powhatan, Ohio. This $1 million pilot plant will use sulphuric acid to leach 40,000 tons per year of aluminium sulphate from coal mine wastes.

Both Allied Chemical and Dixon Chemical Industries have recently announced new processes which could make by-product gypsum suitable for use as a construction material. Should the process be successful, the economic advantage of the wet-process would be materially aided by the new found value for by-product gypsum.

This year the U.S. metals producing industry expects to have used some 1.5 million tons of sulphuric acid in the production of primary metals, while annual consumption of sulphuric acid for uranium oxide refining is estimated at about 820,000 tons annually. Uranium ore processing requires 535 tons of sulphuric acid to process one ton of uranium ore. Production of 1lb. chromium takes about 1lb. of sulphuric acid, 2.04lb. sulphur dioxide, 1.07lb. ammonium sulphate as well as other chemicals. Nickel production, it is estimated, will have used 25 to 1,000lb. sulphuric acid and 1 to 50 million lb. hydrogen sulphide. The newer metal, beryllium, is expected to have taken 7.1 million lb. of sulphuric acid. Electrofining of metals is expected to take up 20 to 50 million lb. sulphuric acid and 1 to 1.5 million lb. sulphur dioxide.

With the outlets below now developing in the domestic market the outlook for sulphur producers is fairly buoyant, provided that the economy as a whole does not slow down too severely.

Export markets for U.S. Frasch sulphur in Europe are expected to narrow in 1961 as the result of increasing sales of French recovered sulphur but elsewhere mounting sulphur demand should favourably affect the level of sales. Continued imports from Mexico and probably increased shipments from Canada, coupled with higher domestic recovered sulphur sales, severely limit the expansion prospects of U.S. Frasch sulphur producers who are unlikely to sell more than 3½ million tons in 1961.

Decline in Mexican Sulphur Production

Royalty arrangements to be terminated

PRODUCTION of sulphur for the first 10 months of this year at 1,092,943 tons shows a decline of 51,041 tons (5.0%) compared with the corresponding period of 1959. This is mainly attributable to the closure of Texas Gulf Sulphur Company's Nopalapa dome in February 1960 which up to then had been producing at a monthly rate of 10,000 tons. Gulf Sulphur Corporation's output declined severely, that of refined natural sulphur and recovered sulphur remained stable, while Pan American Sulphur Company's output at Jaltipan dome soared. Total production for 1960 by Mexico's sulphur industry is expected to reach 1,250,000 tons, about 180,000 tons less than last year. Exports, however, which up to the end October were 13.2% above last year's level are likely to reach 1.2 million tons.

Level of Production

Now that world sulphur prices have stabilised, it can be expected that the pressure by Pan American Sulphur Company for a substantially higher level of output will disappear and that production will be established at the current or even slightly lower level depending on demand. The future of Gulf Sulphur Corporation is in the balance, as faced with bankruptcy the company is attempting to consolidate its financial position.

In this connection it is significant that sales of Gulf Sulphur this year have shown a considerable rise over those for last year, but this has been achieved by recourse to stocks and not from current production. In October, agreement was reached between Gulf Sulphur Company and the Latino Sulphur Corporation regarding a merger.

Operating costs and especially the incidence of royalties are the deciding factors in the profitability of Frasch producers. Pan American, now the largest sulphur producer in Mexico and third largest in the world, has very low operating costs.

Frasch Sulphur

Pan American Sulphur Company. Total production of Azufrera Pan Americana, the Mexican operating subsidiary of Pan American Sulphur Company, for the first 10 months of this year totalled 818,294 long tons, an increase of 83,375 tons (11.3%) over the same period last year, so that this company can be expected in 1960 to produce about 1 million long tons of sulphur and to ship between 950,000 and 1 million tons of sulphur to the export market, a record in the company's history.

Gulf Sulphur Corporation. During the first 10 months of this year Gulf Sulphur Corporation's operating subsidiary Cia' de Azufre Veracruz S.A. produced a total of 172,517 long tons of sulphur, a decrease of 70,673 tons or 46% compared with the same period last year. It is expected that the company's output during 1960 will barely exceed 200,000 tons.

During August plant facilities of Cia' Azufre were closed down for 11 days by a wildcat strike, causing a drop in the level of production to 11,417 tons, compared to 15,388 tons in September and 16,800 tons in October.

The merger of Gulf Sulphur Corporation into a wholly-owned subsidiary of Latino Sulphur Corporation, and a major reorganisation of the company's finances, was proposed in October and now awaits shareholders' approval. (See Company Reports, Page 41). This step has been taken as a preliminary move in complete reorganisation of the company and readjustment of certain outstanding debts, debentures, accrued royalties and rights in the company's sulphur concessions. A complete reorganisation has been necessary as the company could not continue to carry the burden of its fixed obligations on debts, stocks and royalties from the sales of sulphur at the declining level of prices.

Recovered Sulphur

Petroleos Mexicanos. Pemex's total output of recovered sulphur for the first 10 months

of this year is 72,132 long tons, an increase of 26.8% over the corresponding period in 1959 when the company produced 56,860 tons, indicating that the oil industry will produce approximately 85,000 long tons or recovered sulphur this year. The company remains unchalleneged as Mexico's domestic supplier.

Sulphur from Native Ores

Negociacion Minera S.A. Mexico's surface mines, located at Gerritos, State of San Luis Potosi, maintained their average monthly output of 1,500 long tons of refined sulphur to bring this operation's total output for the first 10 months of 1960 to 15,000 long tons of sulphur. The level of sulphur production has been stable but it is believed that plant capacity and output will be increased in the near future.

Exports

During the 10 months period, January to October, exports totalled 1,019,909 long tons of sulphur — an increase of 118,908 tons or 13.2% over the corresponding period of 1959 — and it is expected shipments to world markets in 1960 will approach 1 million tons. In 1959 exports amounted to 1,030,900 tons.

Pan American Sulphur Company. Shipments of sulphur to world markets during the first 10 months of this year totalled 792,610 long tons — an increase of 54,890 tons or 7.4% over the corresponding period in 1959.

COMPARISON OF PRODUCTION

	1959 July/Oct.	1960 July/Oct.	% change
Pan American Sulphur Company			
July	87,643	94,936	+ 8.3%
August	78,231	103,192	+31.9%
September	72,577	96,632	+33.2%
October	83,987	110,548	+31.6%
Total	**322,438**	**405,308**	**+25.7%**
Gulf Sulphur Corporation			
July	26,833	16,555	−38.3%
August	25,270	11,417	−54.8%
September	23,407	15,388	−34.2%
October	20,158	16,800	−16.6%
Total	**95,668**	**60,160**	**−37.1%**
Pemex			
July	6,000*	7,500	+25.0%
August	7,000*	7,200	+ 2.9%
September	7,000*	6,900	− 1.4%
October	6,480*	6,480	—
Total	**56,480**	**28,080**	**−50.3%**
Total Mexican Production			
July	131,976	120,491	− 8.7%
August	122,001	123,309	+ 0.1%
September	114,584	120,420	+ 5.1%
October	122,125	135,328	+10.8%
Total	**490,686**	**499,548**	**+ 1.8%**

* estimated

Main destinations to which Pan American shipped sulphur were as follows:—

	Tons	%
United States	397,291	50.1
France	56,917	7.2
Netherlands	34,260	4.3
Belgium	50,383	6.4
United Kingdom	70,074	8.8
Australia	41,266	5.2
South Africa	65,230	8.2
Others	77,189	9.8

Gulf Sulphur Corporation. Total exports of this company during the first 10 months of this year amounted to 227,297 long tons of sulphur — an increase of 64,018 tons or 39%. Exports in 1960 are likely to exceed 250,000 tons. In 1959 the company exported 200,400 tons.

Principal destinations of Gulf Sulphur exports were as follows:—

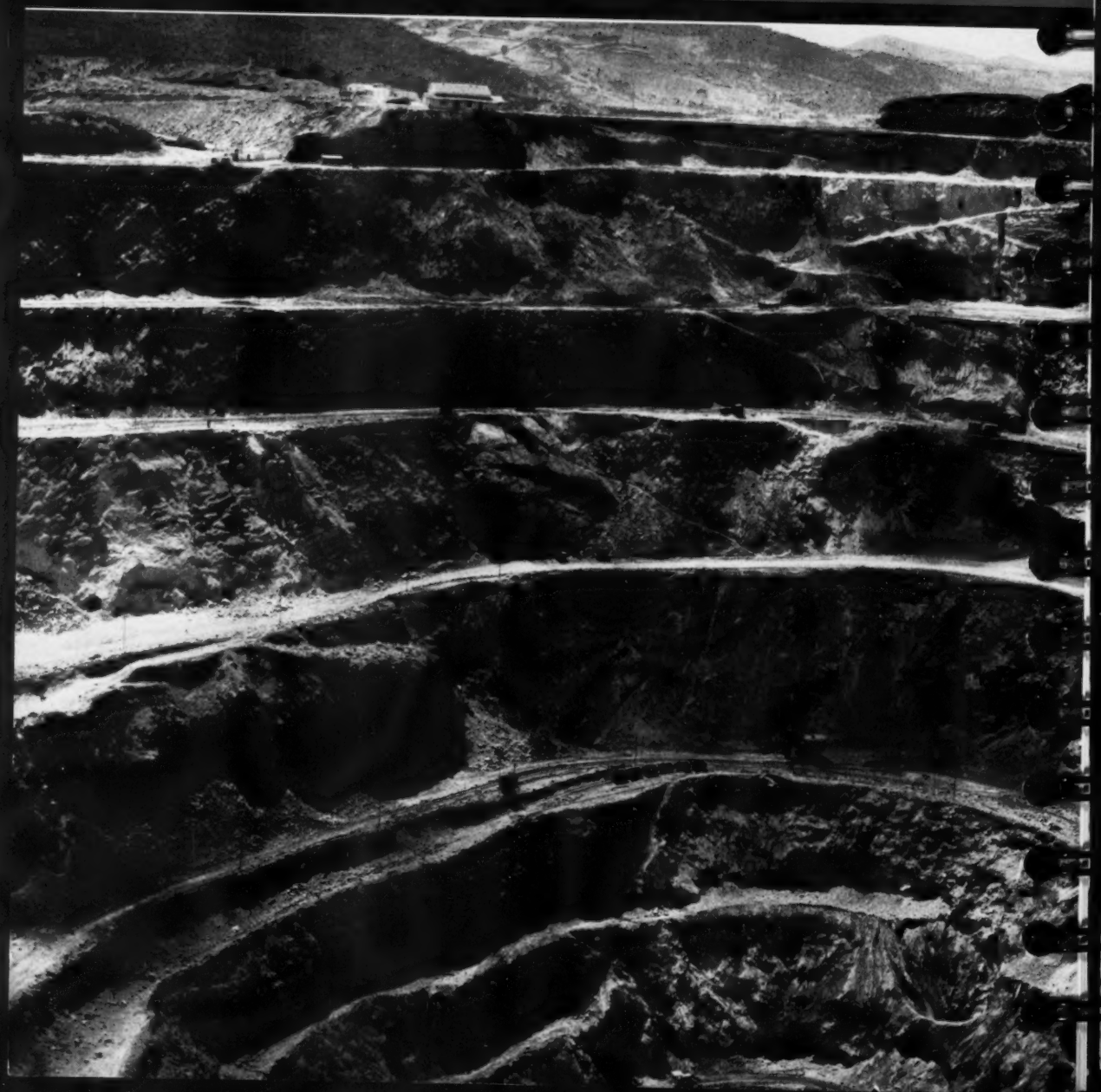
	Tons	%
United States	106,473	46.8
Belgium	16,093	7.1
West Germany	14,119	6.2
Switzerland	19,273	8.5
Australia	28,629	13.5
Israel	32,608	14.3
Others	10,102	4.6

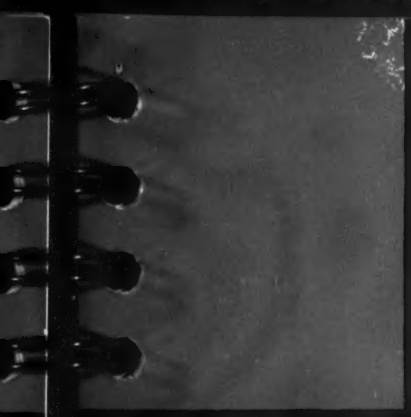
Domestic Sales and Consumption

Consumers in Mexico purchased and apparently consumed 11,951 long tons in the first 10 months of this year, and it is expected that sales and apparent domestic consumption for 1960 will total 145,000 tons.

The level of domestic consumption at an average monthly rate of 120,000 tons is not expected to change materially until the new chemicals, fertilizer and other sulphur consuming industrial plants, now under construction, are completed in 1961. While Petroleos Mexicanos remains unchallenged as Mexico's main domestic supplier of sulphur with deliveries of about 85,000 tons a year, Azufrera Pan American has increased its sales in 1960 in the domestic market. In September the company sold 3,352 tons compared with 1,500 tons in August and 2,417 tons in July; and in the full year home sales should exceed 25,000 tons. Cia' de Azufre Veracruz has also

Pyrites...





COMPAÑIA ESPAÑOLA de MINAS de RIO TINTO S.A.

THE THARSIS SULPHUR AND COPPER CO. LTD.

Pyrites is a stable, assured and competitive source of sulphur. The Tharsis and Rio Tinto mines in Spain have supplied pyrites for over eighty years. Their known reserves are unrivalled.

← "Corta Atalaya" at Minas de Rio Tinto. The depth of the opencast is 250 metres and that of the orebody, of which "Corta Atalaya" forms only a part, is still unknown.

...Europe's principal source of sulphur

increased its local deliveries of sulphur although in September only 240 tons of sulphur found their way to the domestic market as against almost 800 tons in August and July.

The surface mines in Mexico continue selling at about 1,500 tons each month — mainly to their established domestic clients in northern Mexico, whose consumption appears to be stable.

No Intervention

A Mexican Government official describing the work of the Government engineers of the Sulphur Commission appointed "to study the country's sulphur industry" stated that Government engineers were "intervening" in the operation of the sulphur companies. This unfortunate wording was picked up and widely published in the U.S.A., Great Britain, Australia and other parts of the world. Accustomed to the phrase "Government intervention" meaning the take-over or confiscation of property, newspapers, etc., investors jumped to the conclusion that the Mexican Government was taking over control or confiscating the Mexican sulphur properties and the reports caused some of the sulphur stock to drop in price and brought anxiety to consumers.

An ultimatum was delivered to Pan American Sulphur in November to terminate the arrangements whereby royalties are paid to two Mexicans and one American who some time back ceded their concessions to this company. Royalties from 1951 to date total nearly £3 million and are considered by Mexican's Minister of National Property to be an excessive burden on sulphur production.

Outlook

Domestic sulphur demand is for the greater part being met by sulphur recovered by Pemex from natural and refinery gases and by the end of 1962 the present level of supply from this source of about 85,000 tons, should rise to over 100,000 a year as new recovery plants at oil refineries come into operation. Domestic producers of Frasch sulphur can expect domestic sales approaching 50,000 tons in 1961, rising to 120,000 tons in 1962.

Mexico has fertilizer plant projects in hand. The table below shows the country's annual capacity for synthetic fertilizers in 1959 and the planned 1962 capacity.

	1959		1962	
	Tonnes (weight)	Tonnes (plant nutrients)	Tonnes (weight)	Tonnes (plant nutrients)
Ammonium sulphate ...	155,000	31,775	155,500	31,775
Phosphate fertilizers ...		18,330		54,945
Calcium superphosphate	94,000	18,330	165,000	32,715
Triple superphosphate	nil	nil	49,500	22,770

At the La Viga plant of the State-owned Industria Nacional Quimica, Farmaceutica S.A., production of sulphuric acid and calcium superphosphate is to start "in the near future," and in the State of Veracruz, Guanos y Fertilizanes de Mexico is erecting a triple superphosphate plant at Coatzocoalcos, which is due on stream in 1961.

In July this year Hooker Chemical resumed its rôle as supplier of sodium tripolyphosphate (STPP) to the growing Mexican soap and detergent industry with a 30,000 tons capacity plant at Lecheria. Demand for STPP, which just slightly exceeds 20,000 tons a year at present, is expected to increase, and there is a possibility that a second 30,000 tons STPP plant may be required shortly. Some observers estimate that by 1964 Mexican production of detergents will reach 193,000 tons calling for 40,000 tons STPP a year. Others, not so optimistic, put the 1964 market at 30,000 to 35,000 tons.

At its new plant near Monlerrey, Hooker now produce elemental phosphorus from local siliceous phosphate ores. The company's plant at Lecheria produces in addition to STPP, furnace-grade phosphoric acid and tetrasodium pyrophosphate; there is also a possibility of manufacture of grade acid and dicalcium phosphate, tetra-potassium pyrophosphate and sodium hexametaphosphate.

The establishment of a wide range of secondary industries in Mexico is increasing the demand for industrial chemicals and especially for sulphuric acid, production of which can be expected to rise from 275,000 tons to over 500,000 tons in the next three years.

Growing Importance of Recovered Sulphur in Japan

DURING 1959, production of elemental sulphur in Japan totalled 233,000 tonnes, an increase of 53,000 tonnes (22%) over 1958 when output was the lowest for six years. This substantial expansion of output is the direct result of heavy demand by all sulphur using industries and notably rayon and pulp. Output has not yet returned, however, to the previous peak of 258,000 tonnes in 1958.

An important new feature of the brimstone supply position in Japan is the growing importance of sulphur recovered at oil refineries, and output in 1959 totalled 7,700 tons.

Stocks held by producers and consumers at the end of the year totalled 24,000 tonnes, of which 9,000 tonnes was held at mines and 15,000 tonnes by consumers. It will be noted that stocks held at mines have decreased considerably (15%) from 13,600 tonnes held at the end of 1958. Consumers stocks, however, have risen 50% from 10,000 tonnes in 1958 to 15,000 tonnes.

Sulphur Recovered from Refineries

As yet recovery of brimstone at oil refineries in Japan is limited. In the past the bulk of Japan's crude oil requirements were met from the East Indies, the oil being sulphur free. Increasing purchase of Middle East crude ore, however, is being imported to meet Japan's growing oil needs. With the increasing petrochemical production in Japan, it can be expected that output of recovered brimstone will mount at an increasing rapid rate within the next two to five years.

Fifteen other refineries produce between them a further 5,460,000 tonnes a year. Of the oil refineries in Japan, Tawa Toa Neuryo Oil Co. at Shimizu has a 4,200 b.p.d. hydrodesulphuriser unit, and Idemitsu Koson at Shiimgu - Tokoyama a hydrodesulphurisation capacity of 9,000 b.p.d. Total hydrodesulphurisation capacity in 1959 in Japan was 15,500 b.p.d.

Major Oil Refineries in Japan

Company	Location	Crude Capacity 1958 (tonnes/year)
Mitsubushu Kabushikaisha	Kawa Saki	2,500,000
Showa Oil Company	Kawa Saki	1,350,000
Kowa Oil Company	Marifu	1,600,000
Tawa Toa Neuryo Oil Company	Shimizu	2,000,000
Maruzen Oil Company	Shimizu	1,700,000
Idemitsu Oil Company	Tokoyama	2,000,000
Toa Nenryo Kogoyo Oil Company	Wakayama Inland Sea	—
Nippon Petroleum Refining Co.	Yokkaichi	2,000,000
Showa Oil Company	Yokahama	2,160,000

By summer 1961 Nippon Mining Co. Ltd. will have a 5,000 barrels-a-day Houdriformer unit and an 8,000 barrels-a-day hydrodesulphurisation unit at Mizushima in Okayama Prefecture, between Kobe and Hiroshima, the newest Japanese petroleum-chemical area. Target date for completion of the two units is mid-1961.

Matsuo Sulphur Refinery

Results for the first six months at Matsuo Mining Company's large scale pilot sulphur refinery plant have proved even better than was expected. Sulphur recovery rate, on the basis of free sulphur is 95-98%. Fuel consumption is 370-380 Kg/tonnes and waste gas from the retort which is recoverable gives 12% sulphur dioxide gas (wet).

This plant was designed to have a capacity of 250 tonnes sulphur a month, but the preliminary results have shown that 280-300 tonnes sulphur a month can be produced. Matsuo expect to instal an industrial plant having a monthly sulphur capacity of 5,000 tonnes, and which would produce sulphur at half the present cost. The new plant which will include a sulphuric acid plant is to be installed in the course of the next few years.

To utilize grain-sized sulphur ore which cannot at present be treated by the conventional method, Matsuo now have a new plant under construction which is scheduled to be completed by the end of next March.

The process is in general a simple one — namely sulphur distillation by direct firing of heavy oil adapting the furnace to a fluo-solid system, Recovery of the order of 85% is expected with oil consumption of the order of 100 Kg per tonne sulphur consumed and at a cost 30% lower than at present. The new plant will produce 1,200 tonnes sulphur a month.

Consumption

During 1959 the two leading consumer industries recovered from the setbacks experienced from mid-1957 to 1958. Output of rayon in 1959 rose by 11% over 1958 and has

continued its upward trend this year. Growth of markets eased the effects of production control initiated in September 1957 by the Japanese Rayon Producers' Association. Distribution by main Japanese consumer groups in 1959 was as follows:—

Consumed for	Long Tons 1957	1958	1959	% Change 1958-59
Carbon disulphide	129,000	90,000	112,000	19.1
Pulp	89,000	75,000	92,000	18.5
Synthetic fibre ...	13,000	13,000	17,000	—
Others	18,000	11,000	29,000	—
	249,000	189,000	250,000	

The greater (19%) use of sulphur for carbon disulphide manufacture does not fully reflect the upturn in Japan's rayon industry, because of the increasing impact of CS_2 recovery. Demand by the pulp industry has also been strong and has almost returned to the level of consumption noted in 1956 when 93,000 tonnes were required.

The most significant advance, however, has been in the consumption by the synthetic fibres industries which has increased by 30.7% after remaining static at 13,000 tons for the last two previous years.

Sulphur Exports

Exports of elemental sulphur from Japan are now negligible (65 tonnes). Cost of production still remains high and makes Japanese sulphur wholly uncompetitive compared with present world market prices.

Prices for elemental sulphur produced in Japan have remained stable at Yen 19,000 ex mine, which is almost double the current world price (1,000 Yen = £1).

Outlook

Production and consumption of sulphur in Japan in 1959 clearly shows the strong recovery from the difficult market position in the previous year. The expansion in the man-made and synthetic fibres industries, and in wood pulp has raised the level of elemental sulphur production and sales and it is estimated that 1960 production will rise to around 270,000 tonnes. With the ban imposed by the Japanese Government on sulphur imports still in operation, Japan's sulphur demands must be met by greater domestic output. Efforts continue to raise efficiency at mines and treatment plants and more recovered sulphur from oil refineries is becoming available.

The main producers, Matsuo Mining Company's proposed new sulphur recovery will alone increase output by 60,000 tonnes. As regards recovered sulphur, a new plant of about 10,000 tons a year capacity is now being installed, and oil refineries now starting up or due in operation in 1961-63 can also be expected to contribute to sulphur production; it is estimated that within the next few years at least 30,000 tonnes of elemental sulphur will be recovered from this source.

The man-made fibre industry, Japan's largest sulphur user, is now facing the gravest turning point in the post-war years. Now second only to the United States in production volume, indeed, the largest producer of staple in the world, Japan also leads the world in rayon exports. Although still dominant the relative importance of Japan's viscose plant industry has been decreasing in the last few years with the rapid strides made in development of the many new synthetic fibres. In the export markets, because of important restrictions by various countries against Japanese products and also because of the many countries now attaining self-sufficiency in fibres and textiles through establishment of their own textile industries, a more difficult export position cannot be avoided and this situation must be regarded seriously as Japan's chemical fibre industry now exports 45% of its total production and accounts for 26% of the world's exports of man-made fibres. In this respect the industry has apparently expressed anxiety about the high domestic price of sulphur and there is as yet no indication that the sulphur price will be reduced. While the agreement between producers and consumers remains effective no change is likely. The present price may, however, drop with the expanding sulphur production from oil refineries. Of increasing importance should be the substantially lower level of world sulphur prices which is coupled with ample supplies. If backed by the viscose rayon industry and allowed by the Japanese Government, as present information suggests, Canadian recovered sulphur in the next few years could be expected to offer a serious challenge to the Japanese producers.

Australia's Growing Use of Brimstone in First-Half 1960

Sulphuric acid consumption increased 16%

DURING the first half of 1960, production of sulphuric acid totalled 591,208 tons (100% H_2SO_4), an increase of over 81,000 tons (15.9%) compared with the first half of 1959. At the same time 103,248 tons of brimstone was used in sulphuric acid manufacture, an increase of 22,142 tons (27%) over consumption in the corresponding period in 1959. So that brimstone now accounts for just over one-half (51.5%) of total sulphuric acid production.

The rising trend in the amount of brimstone used is expected to continue. The present policy of the Australian Government is not to encourage further plant conversions to the use of indigenous sulphur or the erection of new plants using indigenous materials. With abundant world supplies of sulphur now available there is less reason for using local materials, except where there are outstanding advantages.

The position as regards the sulphur bounty* is still unchanged and industry is awaiting the Government's decision. In the meantime as new sulphuric acid plants, other than at metallurgical works, are installed, they are to be based on brimstone.

Sulphuric Acid Manufacture

As shown in the table below, the proportion of sulphuric acid manufactured from other raw materials declined in the period under review. Consumption of pyrites rose 4.6% to 133,934 tons, but pyrites acid only account for 28.2% of the total production as against 32.2% in the first half of 1959. Similarly, despite a 7.9% increase in the tonnage of zinc concentrates consumed and a corresponding increase in the output of by-product acid at zinc smelters to 67.27 tons (100% H_2SO_4), this represented only 11.1% of the total as against 12.2% in the previous year. Acid manufactured from spent oxide advanced slightly, but whereas the actual quantity of miscellaneous raw materials—lead concentrates and alkylation sludges—decreased 6% from 140,714 tons to 132,315 tons, the volume of acid derived from them increased 17% to 46,537 tons (100% H_2SO_4).

Raw Materials for H_2SO_4 Production

	First half 1959	First half 1960	% change
Imported Brimstone ...	81,392	103,248	+26.8
Pyrites	128,079	133,934	+ 4.6
Zinc Concentrates ...	79,591	85,902	+ 7.9
Spent Oxide	5,126	5,718	+11.5
Lead Concentrates, Alkylation Sludges, etc.	140,714	132,315	− 6.0

* See SULPHUR 28, page 22.

Consumption

Total consumption of sulphuric acid in the period under review was 589,537 tons (100% H_2SO_4), compared with 508,077 tons in the first half of 1959, an increase of 16%. Superphosphate manufacture, the biggest user of sulphuric acid, accounted for 456,687 tons sulphuric acid, an increase of 74,517 tons (19.5%). Acid used for ammonium sulphate manufacture decreased slightly (1.1%) from 37,067 tons to 36,677 tons.

This strong expansion of the superphosphate industry, following an adverse year, reversed the trend of industries other than fertilizers increasing their share of acid consumption. Whereas in the first half of 1959 17.5% of total acid consumption went to industrial uses, other than fertilizers, this year it was only 16.3% notwithstanding that actual acid consumption had risen 7,333 tons (8.3%) to 96,173 tons.

Sulphuric Acid Production

	Tons 100% H_2SO_4 First half 1959	First half 1960	% change
From:			
Imported Brimstone	238,501	304,638	+27.7
Pyrites	164,486	166,798	+ 1.4
Zinc Concentrates ...	62,108	67,027	+ 7.9
Spent Oxide	5,307	6,208	+17.0
Lead Concentrates and others ...	39,772	46,537	+17.0
Total Production	**510,174**	**591,208**	**+15.9**
Average % by Contact Process ...	46.2	47.9	

Sulphuric Acid Consumption

	First half 1959	First half 1960	% change
For Superphosphate ...	382,170	456,687	+19.5
For Ammonium Sulphate	37,067	36,677	− 1.1
For Other Purposes ...	88,840	96,173	+ 8.3
Total Consumption	**508,077**	**589,537**	**+16.0**

Fertilizer Production

There are 21 fertilizer works producing superphosphate in Australia. Production in the first half of 1960 was 1,347,667 tons, compared with 1,118,311, an increase of 20.5%. In the same period sales increased by 15.2% from 1,745,216 tons to 2,011,338. The increase in demand varied from state to state from about 10% to 33%. In the case of South Australia, however, severe drought conditions over the past two years have lowered the demand slightly.

About 34,000,000 acres are sown in grass and clover and last year (1958/59) 23,685,000 acres were top dressed with 1,289,000 tons of fertilizer—about 1 cwt. per acre. In addition, about 975,000 tons of fertilizer was applied to various other crops throughout Australia.

Australian soils suffer from a sulphur deficiency and there is an increasing use of superphosphates strengthened with sulphur.

Superphosphate Production

	First half 1959	First half 1960	% change
Made	1,118,311	1,347,667	+20.5
Sold	1,745,216	2,011,338	+15.2
Change in Stock ...	−626,905	−645,671	
Regular Sulphur Use	**6,734**	**6,743**	**+ 0.13**

Other Industries

Metallurgy and chemicals account for the greater proportion of acid used. There is a prospect of increased titanium oxide production in Australia. British Titan Products' subsidiary, Australian Titan Products Pty., proposes to raise production to 22,000 tons a year by extensions to its plant at Burnie, Tasmania, to cost about £A3,250,000. It is anticipated, however, that demand will exceed 22,000 tons a year and the company has signed an agreement with the Western Australian Government to build a £A4 million titanium oxide plant at Bunbury, 110 miles south of Perth, from which it obtains its ilmenite supplies. The Burnie plant, when it comes into full production, will require about 80,000 tons (100% H_2SO_4) of sulphuric acid a year, compared with current consumption of about 10,000 tons.

The uranium industry which expanded strongly up to last year when the Mary Kathleen plant, Queensland, was added to Australia's existing uranium ore treatment plants at Rum Jungle, North Tasmania, and Port Pirie, continues to provide an important outlet for sulphuric acid.

The growth of secondary industries, notably man-made and synthetic textiles, plastics, pulps and chemicals, points to increasing sulphuric acid demand which together with expanding fertilizer production—forecast at 4% per annum, is likely to raise the level of sulphuric production to 1.25 million tons in 1961. Consumption of brimstone—including that required by non-acid industries which is currently 13,000-14,000 tons annually, is expected to reach 240,000 t.p.a., so that 1961 import needs are likely to rise to at least 230,000 tons.

Sulphur Production and Sales in Italy

(Continued from opposite page)

sold competitively—albeit often with aid of subsidy — represent Italy's remaining export markets.

Italy's Sulphur Exports

Austria	2,012	Tunisia	4,000
France	13,600	Morocco ...	1,000
Greece	16,478	Others	189
Egypt	4,628		
Cyprus	1,235		46,275
Yugoslavia ...	3,135		

Stocks

As the result of reduced production of fused sulphur and increased sales to home and export markets, stocks at the disposal of E.Z.I. declined sharply. At the end of June 1960 they totalled 177,130 tonnes, a decrease of 49,478 tonnes during the year.

Sulphur Production and Sales in Italy

DURING the year ended 20 June 1960 production of fused sulphur totalled 92,994 tonnes, a decline of 42,982 tonnes (31.5%) compared with the preceding twelve month period.

	tonnes		
	1959/60	1958/59	Change
Mainland	30,597	33,826	− 9.5%
Sicily	62,397	102,150	−38.9%
	92,994	**135,976**	**−31.6%**

It will be seen that the greater part of the reduction of the fused sulphur output occurred in Sicily where sulphur ore was used increasingly for the manufacture of sulphuric acid and sulphur concentrates. On the mainland the bulk of the output originated from Soc. Montecatini mines and refining plant, but as shown in the company's annual report, these operations gave little satisfaction.

In July and August of this year output was further reduced to 13,957 tonnes—less than two-thirds of the output during the coresponding period of 1959—of which during these two months Sicilian producers contributed 9,862 tonnes fused sulphur.

Sulphur Concentrates

Reflecting the increased tenor of production at the concentration plants of Trabia and Cozzo Disi output of sulphur concentrates (75% S and 15% H_2O) rose to 39,124 tonnes in the year ending 30 June, 1960, double that of the preceding year. These two plants, together with a third new have a combined annual capacity of 75,000 tonnes, pointing to a substantial increase of output this year; already during July and August, 1960, the level of output was 5% above last year's average. Four-fifths (30,978 tonnes) of the concentrates output was fused, the balance, was placed at Ente Zolfa Italiana's disposal as wet concentrate.

Sulphur Ore

Production of sulphur ore, wasters and filter cake for sulphuric acid manufacture in 1959/60 is estimated to have totalled 330,000 tonnes, an increase of about 48,000 tonnes (15%) over the preceding year.

Domestic Sales

During the trading year ending 30 June, 1960, E.Z.I. sold on the home market 96,167 tonnes fused sulphur, about 4% more than in the preceding year.

Sales of sulphur concentrates, however, doubled to 39,124 tonnes. Over 96% was consumed in the manufacture of carbon disulphide and the balance for sodium sulphite, polysulphides and sulphur dioxide. Grinders and refiners accounted for just over one-half of fused sulphur sales. Manufacturers of CS_2—relying increasingly on fused sulphur concentrates—took delivery of 50,400 tonnes. The overall increase of sulphur demand by this industry—represented primarily by SNIA Viscosa—reflects the continued rise in output of rayon filament, and staple, and of Cellophane. A notable feature of the Italian consumption pattern was the first substantial use of brimstone in sulphuric acid manufatcure which rose sharply in May/June, 1960, to about 10,000 tonnes.

Grinding and Refining

	1958/59	
	Fused	Concentrates
Grinding and Refining ...	49,609	—
Carbon Disulphide	12,757	37,636
Sulphur Dioxide	10,760	60
Sodium Sulphate	1,050	240
Sulphuric Acid	14,376	—
Polysulphides	4,797	1,133
Miscellaneous	2,819	55
	96,167	39,124

Exports

Total deliveries abroad in 1959/60 of fused and ground sulphur amounted to 46,275 tonnes compared with 36,821 tonnes in the preceding year. It is estimated that ground sulphur represented at least 40% of total shipments. France remained an important export market but it is thought unlikely that these deliveries will continue after current contracts with French sulphur grinders expire in one to two years' time. Austria and Mediterranean littoral countries where small shipments can be

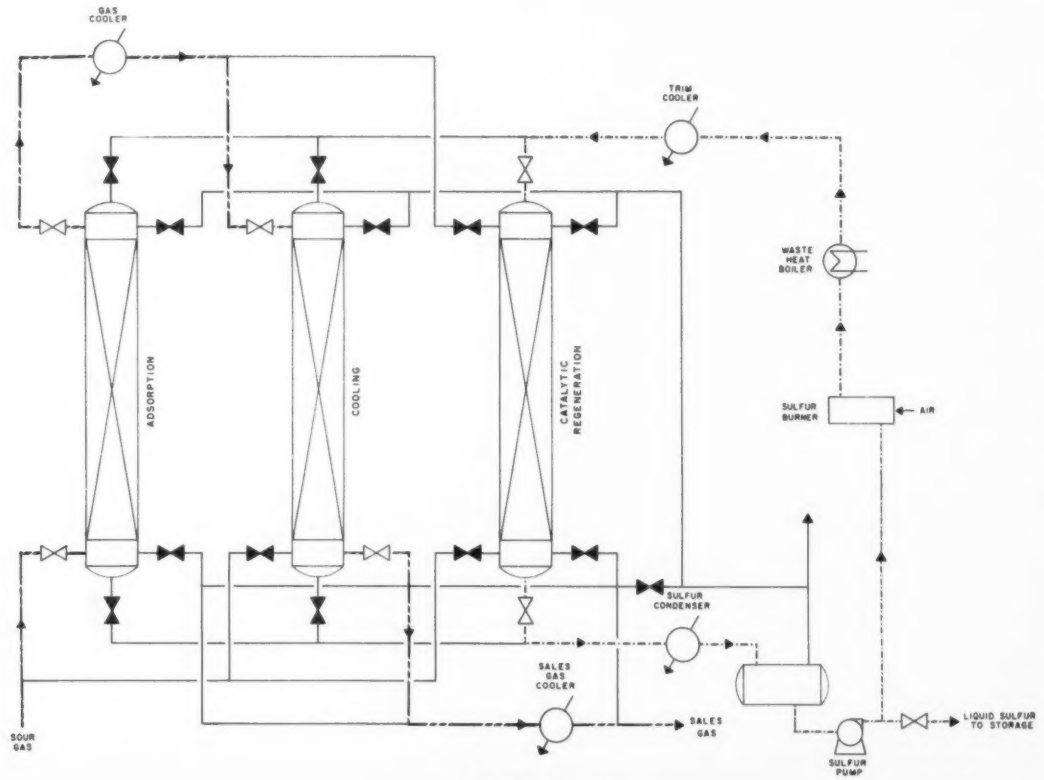
(Continued in opposite page)

Krell Zeolite Adsorption Process Recovers Sulphur from Sour Gas

Canadian gas producers interested

RECOVERY of elemental sulphur from natural sour gas by a new process promising greater economy of operation has been developed by Henry Haines and Krell and Associates Inc., of Houston, Texas. The process employs the adsorption on synthetic zeolites of hydrogen sulphide containing 10 to 30% H_2S, desorption with sulphur dioxide and catalytic reduction of the recovered hydrogen sulphide with sulphur dioxide stripping gas. From the reducing reaction molten sulphur is recovered then burned to form more sulphur dioxide, which is recycled to strip additional hydrogen sulphide from the adsorption beds. During stripping these beds are maintained at about 600°F, but are allowed to cool to the temperature of the raw gas feed during the adsorption step.

The process has only been tried in a laboratory scale so far but design of pilot-plant to treat 100,000 cu. ft. a day of gas containing 15% H_2S (approximately 1,200lb. sulphur) has been completed and construction has begun. Cost estimates based on the laboratory data suggest that a commercial plant to treat 8 million s.c.f.d. of sour natural gas—15% H_2S content or 40 long tons sulphur daily—would need capital of $600,000 exclusive



The Krell Process

of off-site facilities, and operating costs considerably below those of conventional hydrogen sulphide recovery units. The process could therefore become an important factor in natural gas and sulphur output in the United States and Canada.

Since the plant derives its energy requirements from the sour portion of the inlet gas, compared with other processes that burn a portion of the sales gas for fuel, cooling water is the only essential utility.

Steam Credits

With the long-term trend toward higher natural gas prices and a period of relatively low sulphur prices, this differential advantage in "fuel-gas" costs should increase in favour of the Haines Process. Also, in common with all sulphur recovery processes, substantial steam credits can be assigned to the process. The excess steam can be used to drive a refrigerated cooling system for hydrocarbon-dewpoint reduction of the sales gas, an important feature in Canadian operations where gas transmission companies require a 15° hydrocarbon-dewpoint at 800 p.s.i.a.

The process is similar to those employed in short cycle hydrocarbon recovery units, although it uses a different adsorbent and a totally new type of regeneration cycle. The adsorbent is a calcium aluminosilicate, which is manufactured in the form of a synthetic crystalline zeolite. This type of zeolite has been found to be an excellent Claus catalyst. When the adsorbent is "loaded" with hydrogen sulphide, it can be regenerated at 600°F with sulphur dioxide to produce sulphur vapour and water vapour. Liquid sulphur is recovered from these gases by condensation.

Patents

Two patents are held by Krell in Canada and the United States. The company has made an agreement with Western Sulphur Recovery Limited and Western Gas Technologists Limited, who will act as process design engineers, and also with Mahoney-Crawford Tank and Service Company Limited, for supply of equipment from Canada. Patent rights in the United States have been assigned to Sulphur Recovery Inc., Houston.

Process Details

As shown in the diagram on Page 28, the unit is an adsorption plant which operates on relatively short cycles (45 to 180 minutes). Unlike most hydrocarbon recovery units, the time cycle is determined by sour gas concentration rather than limiting superficial linear velocities. The pattern of gas flow is also different, and similar to European adsorption plants, where the gas passes in series through two towers.

Sour gas enters the bottom of the adsorption tower and flows upward. Sensible heat, stored in the sales gas during the adsorption period, is removed by the gas cooler. Cooled sales gas then passes downward through the cooling tower to cool freshly regenerated adsorbent, and then to a sales gas cooler, before entering the sales gas pipeline. In the adsorption tower H_2S is adsorbed on the zeolites. H_2S-loaded zeolites are regenerated when hot SO_2 gases from a sulphur burner flow downward simultaneously stripping and reacting with the adsorbed hydrogen sulphide. Vapours leaving the bottom of the tower contain nitrogen, sulphur vapour, water vapour and small quantities of unreacted hydrogen sulphide and sulphur dioxide.

These vapours are then cooled in the sulphur condenser for production of liquid sulphur, and the non-condensable gases are vented to the atmosphere. Liquid sulphur is pumped to storage.

Approximately one-third of the liquid sulphur leaving the sulphur condenser is re-cycled to a sulphur burner for production of sulphur dioxide gases. These gases enter a waste heat boiler for steam generation and pass to a trim cooler for accurate temperature control.

At the beginning of the catalytic regeneration period the cold adsorbent acts as a heat sink, producing a temperature rise across the tower which is lower than the rise obtained in a conventional Claus catalyst chamber operating under stable conditions.

The small temperature rise allows production of relatively high pressure steam in the waste heat boiler, which has an exit temperature closely approximating the exit temperature

of the catalytic regeneration tower (600°F), without imposing a heavy heat duty on the trim cooler. Unless lower pressure steam were desired the temperature drop across the trim cooler is essentially equal to the temperature rise across the catalytic regeneration tower.

Flow Scheme

Adsorption, regeneration and cooling take place simultaneously but in three separate vessels, each of which is charged with a stationary bed of zeolite. When the bed in the first vessel is saturated with H_2S (also CO_2, H_2O, COS and mercaptans) the flow of gas is switched from one vessel to another on a specified time cycle. At this switchover the second vessel performs the function of adsorption and sweet gas flowing to the third vessel performs cooling of a previously regenerated zeolite bed, while the sulphur burner gases are switched through the first vessel to regenerate the H_2S-loaded bed. When the bed in the second vessel is saturated the sour gas is switched through to the third vessel for adsorption of H_2S while the first one is cooled and the second one regenerated. A third switching completes the cycle and brings the first vessel into the adsorption position again, the second is cooled and the third is regenerated. Piping is manifold to permit switching and introduction of gas flows by automatic opening and closing of valves directed by a "programming" timing device.

Krell and Associates indicate that the temperature rise across the regeneration tower is lower than the rise obtained in a Claus chamber. The heat of the reaction

$$2H_2S + SO_2 = 3S + 2H_2O$$

supplies the heat required to: (1) raise the adsorbent temperature from 150-175°F (after adsorption) to the final regeneration temperature of 500-600°F; (2) desorb the H_2S from the adsorbent. When required, however, the sulphur burner can be operated with excess air to produce additional heat from the reaction

$$2H_2S + O_2 = 2S + 2H_2O$$

As the Krell process performs the additional function of dehydration and H_2S removal, it cannot be compared directly with a Claus unit. While heat recovery in a Claus plant is important for steam to be used for the Girbitol plant reboilers, heat recovery in the Krell process is less important as no steam is required for H_2S removed. Heat recovery per ton of sulphur is stated to be equivalent to that amount obtained from burning half of the net sulphur production in the sulphur burner. It therefore produces a steam-credit for the process.

Economic studies to determine the feasibility of using the new process in Canada have been prepared by Mr. G. A. Van Wielingen, Chief Gas Engineer for J. C. Sproule and Associates Limited at Calgary. Mr. Van Wielingen, estimating that 5,400 long tons of sulphur will be recovered daily in Alberta from sour natural gas within the next four to five years, indicated that his firm, the largest oil and gas consulting organisation in Canada, will continue to provide engineering assistance during commercialisation of the Krell Process.

Sulphur Production Costs

To obtain a sulphur production cost of $10 per ton from the capital investment of $600,000, operating costs are calculated as follows:—

Battery Limits Plant Investment ...	$500,000
Adsorbent cost	$100,000
	$600,000

calculating on a basis of 14,000 long tons sulphur a year (350 operating days a year):—

Adsorbent (2 year life)	$3.57
Operating labour	*
Electricity	†
Steam	‡
Cooling water	$0.75
Maintenance (4% of plant investment)	$1.43
	$5.75/ton
Depreciation, taxes with insurance @ 12.5% of plant investment	$4.47
	$10.22/ton

* = none—fully automatic unit
† = none—steam drives
‡ = none—unit produces excess steam

As such this operating cost for a 44-ton-per-day plant is considerably less than a comparable Girbitol-Claus unit.

The new process can also be expected to have economic advantages in the United States, and negotiations are now under way for a pilot-plant operation there. Under a contract with an American engineering company this second unit would be designed differently from the one in Canada.

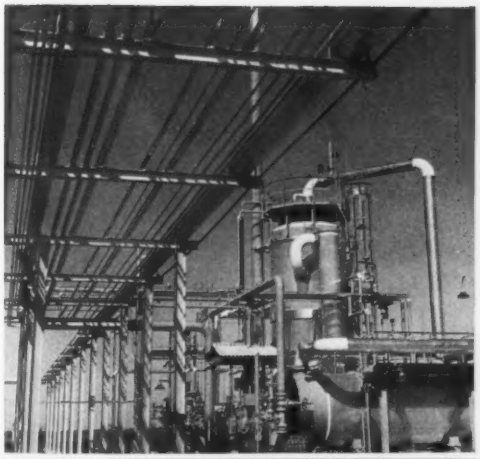
Trans-Jeff Chemical's Sulphur Recovery Unit

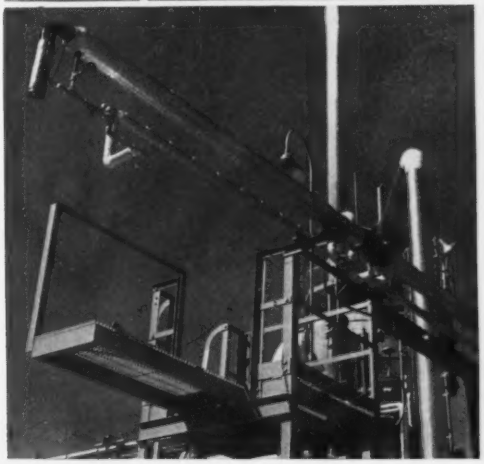
Operates on Texas acid gas

PRODUCTION started at the end of September at the new Trans-Jeff Chemical Corporation sulphur recovery plant in McMullen County, Texas. Trans-Jeff is a joint venture of Transcontinental Gas Pipe Line Corporation, Houston, Texas, and Jefferson Lake Sulphur Company, New Orleans. The corporation was formed last March and construction of the Texas plant was begun in June by Ralph M. Parsons Company, Los Angeles, California as designers and contractors.

Operation of the Plant

Feed gas for the sulphur recovery plant is



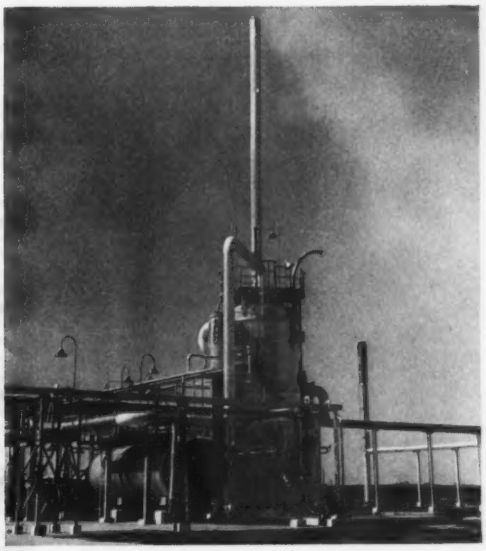


TOP RIGHT: Overhead piping carries feed gas H_2S to the recovery plant

MIDDLE RIGHT : The high converter-coalescer contains bauxite catalyst for reaction between H_2S and SO_2 to form elemental sulphur and water vapour

BOTTOM RIGHT : Molten sulphur from the loading dock is taken on by tank cars fitted with steam coils

BELOW: Overall view showing reaction furnace (horizontal tank) which burns one-third H_2S to form SO_2 and water, the converter coalescer (vertical tower) and sulphur condenser (small tank attached to top left of the reactor



hydrogen sulphide removed as an impurity in a gas-treating plant owned by Transcontinental Gas Pipe Line from sour natural gas supplied by producers in the area. Based on the Claus process, one-third of the gas stream is burned to form water vapour and sulphur dioxide. This burned gas and the remaining two-thirds of the unburned hydrogen sulphide are combined and passed into a reactor chamber. In the presence of a bauxite catalyst the sulphur dioxide and the hydrogen sulphide react with each other, forming water vapour and elemental sulphur vapour. The sulphur vapours are condensed into liquid and drained to a storage pit below.

Capacity

Currently the capacity of the plant is about 30 tons a day, but it is expected that within the next year or so, the plant will be expanded moderately to about 50 tons a day or more.

The sulphur is being kept in molten state for easier and more economical storage and transportation. The melting pit, the tank cars and railway tankers which handle the sulphur are all insulated and equipped with steam coils.

The sulphur recovery plant is Trans-Jeff's first undertaking. The company is, however, studying the feasibility of adding facilities to manufacture other chemical products.

Irish Chemical Industry to have £4 million Sulphuric Acid Plant to be based on Avoca Pyrites

RECENT developments in Eire's sulphuric acid industry, such as Goulding's new plants (see Current Events Page 38) and the now announced £4 million project which will include a 115,000 tons a year sulphuric acid plant (100% H_2SO_4) will mean that by 1963 some one-quarter million tons of sulphuric acid will be produced in that country.

In the last-mentioned and largest project, Irish, Belgian and Canadian interests are combined. These are Shamrock Fertilizers Limited of Wicklow, a joint Irish-Belgian company, Irish Copper Mines, and St. Patrick's Copper Mines, the associate of Mogul Mining Coropration of Toronto, Canada, who own the Avoca pyrites deposits which will be the raw material for the new sulphuric acid plant.

Avoca, site of one of the largest copper mines in Europe, is 40 miles north-east of the new factory. Four bodies of complex sulphide ores totalling about 14 million tons are present. Differential flotation yields a copper concentrate and a pyrites concentrate analysis of which shows it to contain 47-49% of sulphur. Production potential is approximately 100,000 tons a year of concentrates.

A company known as Shamrock Avoca Limited has been formed by the various interests to investigate the possibilities of using Avoca pyrites for production of sulphuric acid. Tests are at present being carried out in Belgium and Germany to determine the type of equipment best-suited for processing Avoca pyrites.

Shamrock Fertilizer Company are themselves installing a 70-ton-a-day brimstone contact acid plant which is on the point of completion. This plant has been constructed and installed by Chemibau Dr. Zieren G.m.b.H., of Cologne, West Germany.

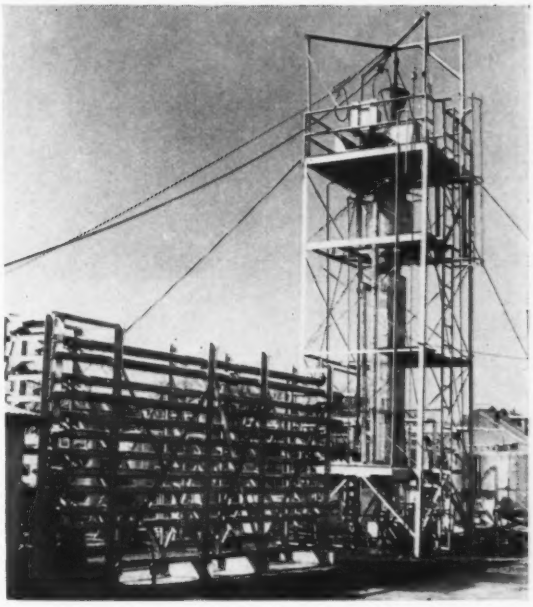
The sulphuric acid will be used in conjunction with imported rock phosphate from ammonium sulphate when ammonia from a new company also expects to manufacture Florida to produce superphosphates, and the projected £7 million nitrogenous fertilizer plant becomes available.

It will be recalled that one of the projects is that at Shannonbridge which was to use peat as raw material to produce 100,000 tons ammonium nitrate fertilizer a year, 20 tons of nitric acid and 110 tons of ammonia a day. Last May the Government of Eire shelved the project, but this latest report of developments at Wexford suggests that the scheme may now be implemented.

The new sulphuric acid project is expected to cost over £2½ million to build and equip and will employ some 500 workers. Annual turnover is likely to be of the order of £3 million a year, of which £2 millions worth may be exported. Site of the factory is such that ships of up to 17,000 tons can berth at the factory's quayside.

New Sulphur Extraction Process Developed by Delhi-Taylor

Offers economic and technical advantages



Delhi-Taylor's 2-ton a day pilot-plant for sulphur extraction

RECOVERY of elemental sulphur from ores by a solvent extraction process which offers economic and technical advantages has been announced by Delhi-Taylor Oil Corporation, Dallas, Texas. The company has obtained a patent (United States Patent No. 2890941 to J. W. Bartlett and Dr. Elton D. Soltes and assigned to the company.)

A diesel grade fuel oil is utilized as a solvent and a unique countercurrent contact ensures that virtually 100% recovery is achieved. Solvent losses due to the gangue are essentially eliminated by using a hot water stripping technique and a pure solvent-free product is produced. Salient features of the process are elimination of moisture, both atmospheric and that present in the ore itself.

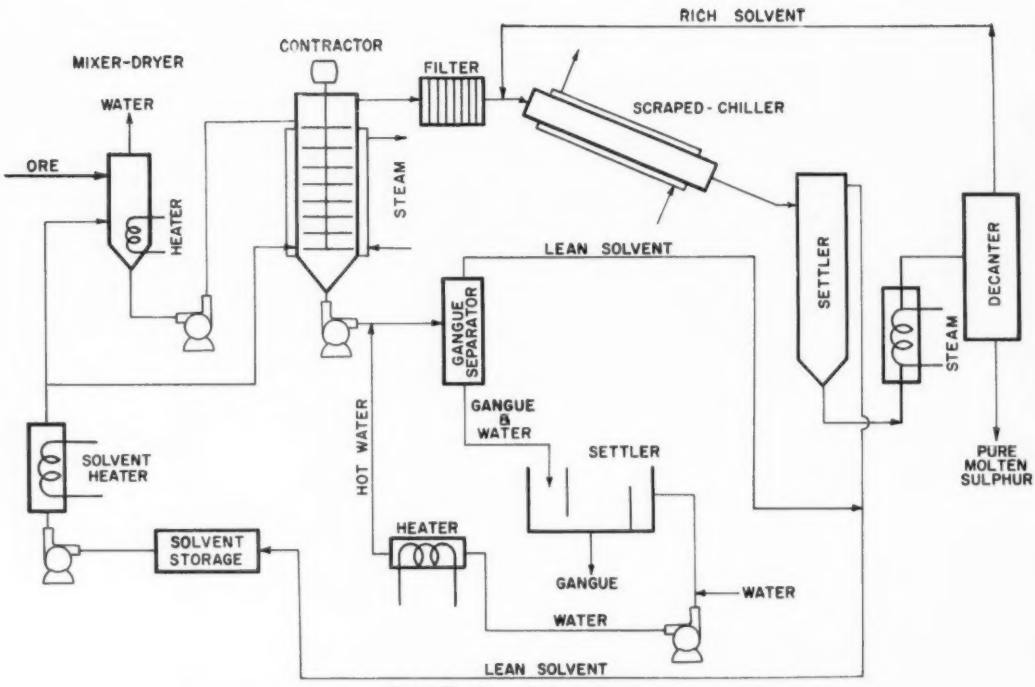
The process has been demonstrated using U.S. sulphur ores in a two-ton a day plant and shown to be an economic proposition.

Process Outline

Pulverized native sulphur ore is fed into a mixer-dryer unit that provides a unique dual function. The ore is mixed with the solvent — a diesel fuel of boiling range 400 - 600°F — to dissolve a major part of the elemental sulphur. The reaction temperature is maintained at 250°F to volatilize free moisture incoming with the ore. Moisture content of most sulphur ores presents serious operating difficulties but Delhi-Taylor's process provides a convenient and effective method of dehydration.

Water-free slurry is fed into the upper section of a steam jacketed contactor unit which contains a number of mechanically scraped trays of conventional design. A second stream of lean solvent is introduced into the lower section of the contactor in such a manner as to meet the downward moving slurry countercurrently and thus to dissolve effectively any sulphur which had previously remained undissolved. Temperature is maintained between 250-260°F in the contactor and the sulphur-enriched solvent is withdrawn overhead through a fine filter to a water-cooled scraped cooler where solvent temperature is reduced to 70-95°F.

Crystalline sulphur is precipitated from the solvent and the resulting slurry is separated, the sulphur-lean solvent being recycled back to the mixer-dryer/contactor circuit for re-use while the sulphur containing residual solvent is passed to a heated decanter where the temperature is maintained above the melting point of sulphur and below the boiling point of the



Delhi-Taylor sulphur process

solvent. Pure molten sulphur is withdrawn from the bottom of the decantation vessel either for shipment in liquid form or to be cast into blocks. Separated hot solvent containing some sulphur is recycled to the scraped cooler circuit for reprecipitation of the sulphur valves.

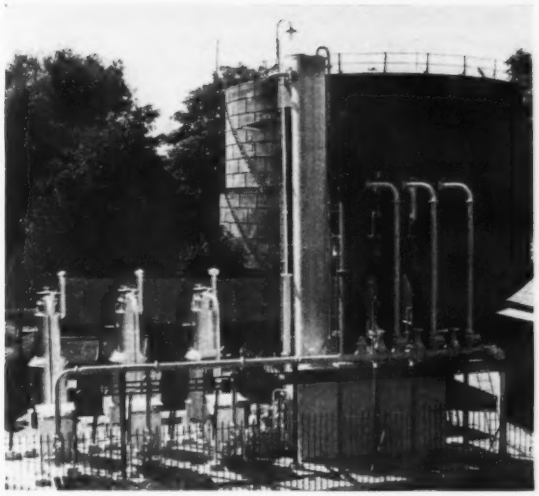
Sulphur-free gangue is recovered from the bottom of the contactor unit as a solvent slurry. This slurry is treated with a stream of 170°F water which displaces the solvent from the gangue.

The three-phase slurry is passed to a gangue separator where lean solvent is withdrawn from the top of the vessel to be cycled back to the fresh solvent circuit; gangue and water are withdrawn from the bottom and passed to a thickener where the water is recovered and recycled to the gangue separator circuit. Solubility of sulphur in the diesel grade solvent employed in the process approaches 10% by weight at 250°F; thus total solvent requirements are preferably 15 to 1, oil to sulphur ratio. Solvent losses have proved to be low and the sulphur produced is bright yellow, and solvent and arsenic-free.

Amorphous Sulphur a Polymer with a Helical Structure ?

USING X-ray and paramagnetic techniques to study amorphous sulphur, Dr. A. G. Pinkus and Dr. J. L. McAtee, Jr., of Baylor University, Waco, Texas, have found that amorphous sulphur appears to be a polymer with a helical structure, eight sulphur atoms making up one loop. They have not been able to discover, however, the direction of the spiral's twist. They believe that it may wind in two directions, so giving a racemic mixture. Clue to these investigators' findings was revealed by amorphous (carbon disulphide insoluble) sulphur's X-ray pattern, which is characteristic of a crystalline material.

New Gas Sweetening Processes — Stretford and Catacarb



The purification plant of the Stretford process at Whitchurch

USING anthraquinone di-sulphonic acids, a new process, known as the Stretford process, for removing hydrogen sulphide from gas, and recovering pure elemental sulphur from coal gas, petroleum gases and other gases, is already in operation at two North-Western Gas Board Works, Rochdale Road, Manchester and Whitchurch. Developed by a team of North-Western Gas Board technologists led by Dr. T. Nicklin, the Board's Chief Scientist, and the Research Department of Clayton Aniline Company under Dr. E. Brunner, the company's research manager, the process is far-reaching in its industrial applications as well as being of immediate interest to the gas industry, because of its cheapness, cleanliness and safety.

Developed in 18 months, and tested on a commercial scale for the past 12 months, the Stretford process solves a problem which has long concerned gas industry scientists; perfection of a commercially practicable liquid purification system using materials that can be regenerated and used over and over again in a continuous cycle.

Outline of the Process

Essentially the Stretford process consists of washing the gas to be purified with a mixture of the sodium salts, dissolved in water, of two special forms of anthraquinone di-sulphonic acids. These are the 2 : 6 and 2 : 7 forms whose molecular structure gives them a specially speedy reactivity. The process is cyclic, continuous and automatic, the liquid reagents being regenerated in the course of the cycle as the sulphur is filtered out in a finely divided form. Cost of purification has been about 0.2d. per therm (0.00095d. cu. ft. of gas) at Rochdale Road and Whitchurch, and at times as low as 0.1d. per therm, according to the market price obtained for the recovered sulphur. This compares with the removal of H_2S by iron oxide which costs about 0.3d. per therm.

Purification Cycle

Four steps are involved in the purification cycle.

First Step. The foul gas passes upwards through a washing chamber meeting the anthraquinone disulphonic sodium salt solution, injected as a spray at the top of the chamber as it flows downwards as a film over the washing grids. In this step, the solution removes H_2S from the gas. The gas passes out of the washer at the top ready for use.

Second Step. The solution carrying H_2S with it passes into a reaction tank where it is allowed to remain for sufficient time to permit H_2S to react with the carbonyl radicals of the solution to produce free sulphur and the corresponding hydroquinone.

Third Step. From the reaction tank the solution is pumped to an oxidation tower through injectors which entrain sufficient air to

convert the hydroquinone back to the original quinone, ready for another cycle.

Fourth Step. Before the solution, now containing free sulphur, returns to the washer to start a fresh cycle, it is passed through a continuous rotary vacuum filter which removes the sulphur.

Applications

Industrial applications outside the gas industry envisaged by N.W.G.B. and Clayton Aniline Company include:—

- Removal of H_2S from the gases now blown to waste in the oil fields, resulting in the recovery of marketable sulphur and elimination of unpleasant smells
- Treatment of waste gases at oil refineries and tail gases sold to the chemical and gas industries.
- Cheap purification of a wide range of liquid products contaminated with H_2S and carbon disulphide from the air, thus cheapening manufacture by preventing degradation of the active carbon used.
- Recovery of elemental sulphur in the purification of synthesis gas.

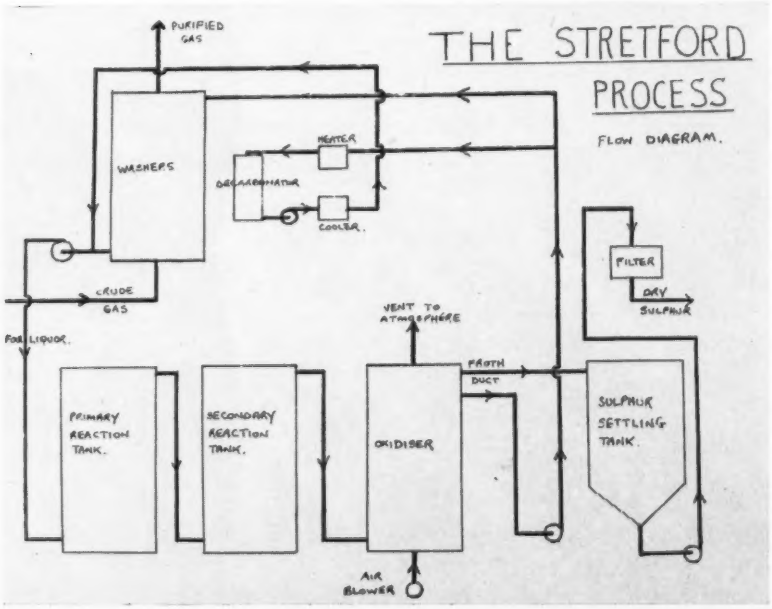
Licensing Arrangements

Arrangements have been entered into by the Gas Council to grant licences—if patents are granted—to exploit the Stretford process to six U.K. chemical engineering companies. These companies are :—Humphreys & Glasgow Limited, R. & J. Dempster Limited, Simon-Carves Limited, W. C. Holmes & Company Limited, Newton Chambers & Company Limited, and Woodall-Duckham Construction Company Limited.

Installations

The Whitchurch plant is a small pilot-plant and has been designed to use the Stretford process by W. C. Holmes Limited. At Linacre, one of N.W.G.B.'s largest works, the original Manchester plant has been suitably converted by Holmes so that the Stretford process can be used. It is treating 6 million cu. ft. of gas daily and is performing well under adverse conditions, i.e. a converted plant. Also in operation since November is a converted Holmes Manchester plant at the Stapleton Road Gas Works, Bristol. Other Manchester plants scheduled for conversion to the Stretford process are those at Gloucester and Bath.

A recent improvement in the process is the use of sodium vanadate as catalyst. As



Flow diagram of the Stretford process

Initial removal of H_2S from the gaseous phase depends on absorption of H_2S in the alkaline washing medium of salts of one or more anthraquinone disulphonic acids (conc. 3 - 4 times equivalent H_2S concentration). A high pH is necessary — pH 8.5 to 9.5.

originally conceived the sodium salt of the anthraquinone disulphonic acid in alkaline solution flows downwards, in a washing chamber, while foul gas passes upwards. Elemental sulphur is deposited in the liquor and a reactor or retention tank is incorporated for sulphur removal. Use of sodium vanadate which it is believed acts as an oxidant, speeds up the reaction.

If thiosulphates are allowed to form, elemental sulphur is not deposited but reacts with the thiosulphates. Beside the loss of elemental sulphur some of the dyestuff is also lost.

At the Whitchurch and Linacre plants dyestuff loss is stated to be negligible.

Price of Dyestuff

Cost of the anthroquinone di-sulphuric acids at present is fairly high, but with the greater quantities required as more plants come into operation, the price can be expected to be reduced. Clayton Aniline Company are producing the dye in batches, but with the wider installation of the Stretford process, production will become continuous.

Wide interest in the process has been aroused and it is learned that a West German company is interested in obtaining a licence while the Burma Oil Company (Pakistan Trading) Limited, is examining the economics of the process together with those of several other suitable processes for treating sour gas from the Sui gas fields. Sui gas contains 2.6% H_2S and about 9.7% CO_2. Burma Oil wishes to recover high-purity elemental sulphur as such. As obtained from the Stretford process after vacuum filtration the firmly divided sulphur can be autoclaved and then poured into moulds or can be produced as flowers of sulphur.

Catacarb Process

An acid-gas absorption process known as the Catacarb process has been developed by a U.S. consultant, A.G. Eickmeyer, and a commercial installation is in operation in the South West. Other Catacarb plants are under contract.

The Catacarb process removes CO_2 in addition to H_2S, and is stated to resemble the Giammarco-Vetrocoke process in some respects, except that non-poisonous catalysts are used. As with the Stretford process, an existing system can be converted and can treat a greater volume of gas than the original unit with lower operation costs.

Chemibau Dr. A. Zieren Acid Plants for Iran and Madras

CHEMIBAU Dr. A. Zieren GmbH of Cologne, West Germany, is to deliver to Iran a sulphuric acid plant with a daily production capacity of 10 tonnes. Based on brimstone the unit, to be erected near the Iranian capital of Teheran by June of next year, has an initial value of some £42,000. Chemibau won the order in the face of strong competition from France and Italy.

Complementing an existing small-scale acid plant which serves solely to supply the Iranian army with raw material for munitions production, the new plant will cover completely the total national sulphuric acid demand other than that captively met by the Abadan refinery. Meanwhile Iran's sulphur ore deposits are to be explored further and it is considered likely that an order will be placed by the Iranian authorities in the near future for a sulphur refining unit.

Fertilizer Plant for Madras State

The Chemibau company will also collaborate in setting up for Premier Fertilizers Limited a plant at Cuddalore with a capacity of 40,000 tonnes of superphosphate and 16,500 tonnes of sulphuric acid. The plant is expected to go into production early in 1962 and to meet its needs about 6,000 tonnes of brimstone and 2,000 tonnes of rock phosphates for the plant will have to be imported annually.

current events

EIRE

Goulding's Marina Acid Plant on Stream

Now on stream at its Marina factory is Goulding Fertiliser Limited's new sulphuric acid plant. Built by Simon-Carves Limited the plant is the first in Eire to use a modern compact unit of the contact type. It is based on brimstone, uses vanadium oxide as catalyst and has a capacity of 70,000 tons per year of sulphuric acid (100% H_2SO_4). The sulphuric acid will be used for many industrial and other purposes as well as for the production of superphosphate. Supplies from Marina will be available in all grades and strengths.

First Triple Superphosphate Plant

For the first time in Eire, also, there will be a plant for production of triple superphosphate. Goulding's Marina plant has a capacity of 21,000 tons a year.

UNITED STATES

Sulphur Dioxide in Tight Supply

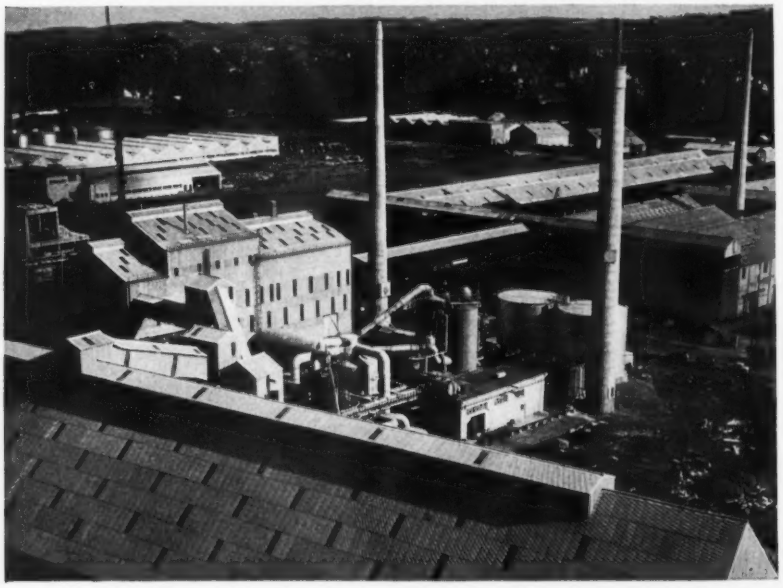
To ease the supply situation on liquid sulphur dioxide, Virginia Smelting Company have just brought on stream a second unit of substantial but undisclosed capacity at their West Norfolk, Va., facilities.

Also entering the liquid SO_2 market are Stauffer Chemical Company. Their new facility at Baton Rouge, Louisiana, came into operation in November. Rated capacity of the plant is 10,000 tons of liquid SO_2.

Although Stauffer is a major producer of sulphur, sulphuric acid, carbon disulphide and sulphur chlorides, this is the company's first unit for the manufacture of sulphur dioxide.

Virginia Smelting's new unit is using what is described as a unique new process design, engineered by the company's own staff. It will cost about $750,000.

Sulphur dioxide as a highly purified, water-white liquid, is used in a variety of end products, including foods (as a preservative), antibiotics and paper pulp. Supplies of SO_2 have been lagging behind demand for some time in the U.S. Virginia Smelting hope that their expanded facilities will encourage investigation of new applications as well as alleviating the present shortage.



General view of the Goulding factory at Marina, Cork, showing the new sulphuric acid plant (centre)

AUSTRIA

New Superphosphate Plant in Styria

Production of superphosphate is due to start in the middle of 1961 at a new plant of Bleiberger Bergwerks Union A.G. of Klagenfurt, a nationalized enterprise. Annual output will be about 30,000 tonnes superphosphate, based on by-product sulphuric acid from the company's lead and zinc smelter at Arnoldstein. Because of this additional demand of sulphuric acid about 12,000 tonnes a year for superphosphate production, less acid, will be available for delivery to customers.

Austrian demand for superphosphate fertilizers is at present approximately 220,000 tonnes annually and is met by 15,000 tonnes produced by Osterreichische Stickstoffwerke A.G. at Linz, to date the only Austrian superphosphate manufacturer, and imports.

Purchase of raw materials for the new plant and production is to be arranged jointly by Bleiberger Bergwerks Union and Osterreichische Stickstoffwerke which will provide the services of experts and know-how to assist with the construction of the new plant.

Austria's Investment Fund for Nationalized Industries will finance the project and will grant Bleiberger Bergwerks Union an interest-free loan of 13 million schilling (£163,000). It is expected that this loan will not be repaid but will be balanced by an increase of the share capital of Bleiberger Bergwerks Union.

Donau Chemie's New Acid Plant

Oronzio de Nora-Impianti Elettrochimici, Milan, Italy, have signed a contract with Donau Chemie A.G. of Vienna, Austria, for the supply and erection of a complete De Nora-Monsanto sulphuric acid plant at Moosbierbaum. At this same site Donau Chemie had a sulphuric acid plant before the Second World War, but it was completely dismantled by the Russians before leaving Austria and the equipment was removed. The old plant was a pyrites-burning unit.

The new Oronzio de Nora-Monsanto plant will be a 125 tonnes-a-day sulphuric acid plant burning brimstone. Steam will be recovered for use in other chemical plants which will be built at the same site by the time the new sulphuric acid unit goes on stream. Monsanto vanadium catalyst will be used in the converter.

The Moosbierbaum plant will render redundant the plant which Donau-Chemie operate at Liesing and this will be closed when the new plant comes on stream.

MOROCCO

Safi's Sulphuric Acid and Superphosphate Plans

Morocco's Five-Year Plan 1960-1964 envisages the transformation into products on site of increasing importance of raw materials in preference to their increased exports. Prominent among these is phosphate rock.

An important project is being advanced at Safi which will utilise phosphates from deposits at Kachkate—previously known as Louis Gentil—pyrrhotite from the Keltara mine near Marrakish and natural gas from the deposit near Mogador—previously Essaouira.

The Safi chemical centre is to produce annually 400,000 tonnes sulphuric acid, 200,000 tonnes superphosphate, 150,000 tonnes phosphoric acid, 25,000 tonnes of ammonia and 100,000 tonnes of ammonium phosphate.

Capital investment will be about £15 million; of which about half the first stage will be furnished by a Moroccan-Dutch company in which Royal Dutch Shell will have a 55% share and BEPL (Bureau d'Etude et de Participations Industrielles) 45%.

The main object of the plan is the creation of a chemical industry and increased production of phosphates to 10 million tonnes by 1965.

EGYPT

Simon-Carves Acid Plant for Kafr El Zayat

Société Financière et Industrielle d'Egypte have awarded a contract to Simon-Carves Limited, Cheshire, England, for a complete sulphuric acid plant to be constructed at Kafr El Zayat. Experts of Cremer and Warner Limited of Westminster, London, who investigated site conditions at Kafr El Zayat, adjudicated the tenders.

The new plant, which will have a capacity of 150 tons of sulphuric acid (100% H_2SO_4) a day, will be based on brimstone. The unit will be self-contained and will have its own water towers. Also, as well as steam raising equipment, the plant will incorporate a power-

producing unit capable of developing an excess of electricity for feeding back into the factory mains. Steam will be generated at 350 p.s.i. and the turbo alternator will be of the condensing type with some of the steam taken off at about 50 p.s.i.

Work will begin on the factory buildings in two or three months' time. The plant will be shipped to Egypt by December next and the factory is expected to be ready to be on stream about the middle of 1962. Estimated cost of the plant is £300,000.

This is the second acid plant Simon-Carves have built for the company. The first one was a 50 tons per day installation producing acid from pyrites and has been in operation for more than 11 years.

This plant is still producing acid at slightly over its rated capacity with high efficiency. The design of the plant was based on the burning of Cyprus pyrites but has recently been using any type of pyrites such as Yugoslavian pyrites, dependent upon what currency has been available. It was built at the same time that Simon-Carves constructed a similar plant of the same size in Egypt also treating pyrites; both plants have a capacity of 50-tons-a-day of sulphuric acid. Gas purification equipment at the older plant was of the usual type comprising dust precipitators, gas-washing and cooling towers, followed by two single-stage mist precipitators in parallel. When burning Cyprus pyrites which has comparatively low content of arsenic, the sulphuric acid produced was arsenic free. Selenium has also been recovered in small quantities in the existing plant by skimming the weak acid system.

The company have three other pyrites-based sulphuric acid contact plants at Kafr el Zayat having a total acid (100% H_2SO_4) capacity of 105 tons a day. Two of these were built by Induschimie and one by Krebs.

Brimstone for the new plant is likely to be obtained from the company's sulphur mine on the Sinai Peninsula.

AFGHANISTAN

Refined Sulphur Projects

Sulphur ore deposits in Northern Afghanistan have been under investigation for some years especially since the advent of the U.S.S.R. technical mission.

Russian mining experts have now established that the largest deposits in the Elburs mountains near Mazar-i-Sherriff contain approximately one-half million tons of 40% sulphur ore. These reserves are inadequate to justify realising the Afghanistan Government's plan for a 30,000 tons per annum sulphur refinery, and it is now expected that the recommendations of the Russian experts—to build a 10,000 tons per annum refinery—will be followed. The project plans provide for the completion of the refinery in 2½ years, but as yet there is no adequate outlet for sulphur in Afghanistan where domestic consumption is currently between 500 and 1,000 tons per annum used mostly for pesticides. Exports, in particular to India or Pakistan, are unlikely to be economic on account of high transport costs and the present home market is already met by a number of small, relatively primitive enterprises, which produce a few hundred tons of fused sulphur which is sold in the form of blocks.

Also to be carried out under the Second Five-Year Plan is a project by the Afghan Ministry of Mining and Industry for the construction of a sulphur refinery with an annual capacity of some 3,000 tons flowers of sulphur destined exclusively for domestic use.

BRAZIL

Sulphuric Acid Plant for Ouro Preto

A West Germany industrial group already interested in the mineral-rich Brazilian province of Minas Gerais is engaged in negotiations with the State authorities of Minas Gerais for the building of a sulphuric acid plant there. The acid works, to be on the site of the pyrite deposits, would use these as raw material. Negotiations are said to be at an advanced stage and are expected to be concluded successfully very shortly.

With regard to other sulphuric acid plant activities, the local subsidiary of Farbenfabriken Bayer A.G., Leverkusen, West Germany, Bayer de Brasil, is building a second sulphuric acid unit to boost its production to 100,000 tons a year.

At present Brazilian sulphuric acid production is about 250,000 tonnes a year.

COMPANY REPORTS

Gulf Sulphur Corporation's Proposed Merger and Financial Reorganization

In its plan of reorganization, Gulf Sulphur Corporation is proposing to merge with Latino Sulphur Corporation, both Delaware Corporations. The purpose and effect of the proposed merger is to reduce all outstanding stock of the company to one class of stock. All rights to accumulated dividends on the preference stock will be eliminated but there will be no change in the properties, operations or name of the company.

Under the agreement of merger the present common stock and class B common stock on a share for share basis and the present preference stock would be converted to one share for four shares of new stock. This would result in 2,948,806 shares of new stock being outstanding.

Reasons for the Merger

Gulf Sulphur is in a precarious financial condition and is faced with the necessity of substantially adjusting its capital structure if it is to continue operations. The financial structure of the company was planned in 1955 when the market price for sulphur was approximately 50% higher than to-day's market price. Under the present market conditions the company is unable to carry its fixed obligations of interest, sinking fund requirements and payments to royalty owners. To meet the situation, there is a plan of reorganization whereby a substantial portion of Gulf Sulphur's debts and royalty obligations will be converted into common stock. Approximately 13,320,000 shares of stock will be offered in cancellation of some $2,037,000 of debits, $446,000 of accrued royalties and $4,561,500 of debentures and in exchange for the privately held royalty interests in the Mezquital sulphur concessions of the company which amount to $2.75 per tonne. If the plan of reorganization is accepted by shareholders for at least $2,000,000 of debts and royalties, 75% of debentures and 90% of royalties, 10,110,000 additional shares of common stock will be issued and about $2,410,000 of debts and debentures and 10% of royalty interests would remain outstanding.

The proposed reorganization plan will permit the company to operate at a profit under prevailing market conditions.

Gulf Sulphur have also been negotiating for an adjustment of its obligations with respect to royalties payable to the Mexican Government.

Jefferson Lake Sulphur Express Concern at Sulphur Pricing Policies

"World consumption of elemental sulphur during 1960 has continued to increase, and it appears that this calendar year will show an increase, in the markets to which we export sulphur, of approximately 30% over the year 1959." **Eugene H. Walet, Jr., President, Jefferson Lake Sulphur Company.**

Sulphur production at the United States plants of Jefferson Lake Sulphur Company was 240,630 long tons in the nine months ended 30 September 1960 and tonnage sales in the same period were 271,783 long tons. Prices, however, are described as being at the lowest level in nine years, having decreased by 36% since 1956. During the last 12 months, in fact, the price dropped a further 9%, an average decrease of $1.81 per long ton f.o.b. mines.

The company suggests, however, that sulphur prices in several countries are firming and the downward trend may have reached bottom. "We have expressed, on a number of occasions, our disagreement with certain pricing policies which have been pursued heretofore by the industry at large." Based on actual sulphur tonnage sales, had the price of sulphur remained stable during the past year, earnings for the period would have reflected an additional $492,000 and a total of $667,855.

In his first quarter's report Mr. Eugene H. Walet, president, notes that the acute decline in price received by Jefferson Lake for sulphur results, primarily, from the sale and pricing policy pursued by the Sulphur Export Corporation (Sulexco), Jefferson Lake who own 18% of Sulexco are opposed to this policy. Through Sulexco Jefferson Lake sold 66.50 of its total tonnage sales made in the first quarter of 1960.

In the company's interim report for the six months ended 30 June 1960, Mr. Walet states that the continued erosion of the price received for sulphur had had the greatest direct effect on profit potential, particularly in the light that Jefferson Lake mines sulphur from naturally lean deposits.

Jefferson Lake Petrochemicals of Canada Limited, Jefferson Lake's 69% owned subsidiary, continues to operate efficiently and economically, producing sulphur of highest quality; sales and shipments are currently increasing. Agreements have been entered into with Mobil Oil of Canada and other companies and owners to develop gas resources in the East Calgary field. Jefferson Lake will be the initial operators of plant and field operations in this field.

By November 1961 Westcoast Transmission Company will be ready to receive 100 million cu. ft. of pipeline gas daily from the East Calgary field. By

this time Jefferson plan to have erected a sulphur plant at Savanna Creek. Preliminary agreements have been reached with the railways to proceed with the installation of tracks to the plant site to expedite construction of plants and facilities, and for transporting sulphur and liquid hydrocarbon products which will be produced.

Most recent estimates of natural gas reserves in the East Calgary field, which covers about 200 square miles, are 1.1 trillion cu. ft. which is expected to become, as development proceeds, over 1.5 trillion cu. ft. No estimate is given for the amount of sulphur which will be recovered, but the tonnage will be large.

Net profit of the parent and its subsidiary for the nine months under review was $175,855. No taxes were paid because of a tax loss carried forward. Charges amounted to $1,077,689, including depreciation, depletion and amortisation of $714,037, non-productive drilling costs of $11,804, interest charges of $283,737, and other non-recurring charges of $68,111.

In the corresponding period for 1959 the net profit was $59,845.

Profit of the parent company was $155,112 ($58,112) and for the subsidiary (69% owned) the net earnings were $63,675.

Purification of Gases the Main Item on the Gas Council's Research Programme

COAL and oil used for gas-making in the year ended 31 March 1960 in the United Kingdom totalled 22,317,000 tons (24,179,000 tons in 1958-59) and 750,000 tons (667,000 tons) respectively, the Annual Report of the Gas Council 1959-60 indicates.

New gas-making plant to a total capacity of 54 million cubic feet a day (107 million) was brought into use during the year and plant of a total capacity of 75 million cubic feet (130 million) was scrapped. Of the new plant 29 million cubic feet a day was for gasification of oil. At the end of the year 428 works were in operation compared with 1,050 at vesting date.*

Gas Purification

A main item in the Council's research programme continues to be purification of gas. The removal of hydrogen sulphide from gases containing only small amounts is receiving special emphasis since several newly-developed gas-making or gas conversion processes give rise to the appearance of a few parts per million of H_2S and hence development of processes suitable for purification of such gases is being studied.

Also being studied is the recovery of sulphur from the waste gases of purification processes.

New Processes for H_2S Removal

The Gas Council reports that although the purification of gas by the use of iron oxide in modern tower and tower-box purifiers is very efficient and cheap, whenever relatively large concentrations of H_2S are present, this reagent is not satisfactory for removal of traces of H_2S such as arise in many of the newly-developed processes of gas-making. Such traces can best be removed by use of liquid reagents, and recent small-scale work has indicated the value of solutions of certain organo-metallic compounds for this purpose; these are now being developed on a pilot plant scale.

In removing carbon dioxide from shifted water gas, any residual H_2S is also washed out. Since the H_2S may not be discharged to atmosphere, a method for its conversion to sulphur has been developed and arrangements are now in hand for testing this catalytic process on a pilot-plant scale.

*1 May 1959.

Plant Operations

South Eastern Gas Board's process for removal of H_2S from crude gas by means of an organic oxygen carrier (methylene blue) has encountered difficulties in operation on the pilot scale. Alternative solvents are now being tried on a pilot-plant scale.

A system of liquid purification of gas by which sulphur is eventually removed by filtration† has operated on a small scale at Whitchurch since May 1959, and in large-scale plant at Manchester. At the East Midland Board's Whitchurch plant, work has begun on the catalytic organic sulphur removal plant, and at Basford, Nottingham, an experimental unit designed to remove H_2S and a large proportion of organic sulphur, using a fluidised bed of oxide, is under construction.

Tower purifiers have been brought into operation at the West Midlands Board's Foleshill Works, Coventry, and at Worcester. Installation of the Gastechnik purification plant at the Wales Board Aberavon Works, Port Talbot, has been completed, purification capacity at Newport and Shotton is being increased, and tower purifiers have come into operation at the new carbonising plant at St. Albans of the Eastern Board. At Reading in the Southern Board area, Gastechnik and associated sulphur extraction plants came into operation in October 1959.

At Exeter the South Western Board have started construction of an organic sulphur extraction plant, which, when developed, will be the forerunner of several others so as to enable the Board to supply gas virtually free of sulphur.

Spent Oxide

The market for spent oxide in 1959-60 was exceedingly weak, the Gas Council records, but allowing for a relatively small and declining volume of exports, production was roughly in balance with consumption for sulphuric acid manufacture. As a result of plentiful supplies of sulphur, prices of sulphur-bearing materials were low and the financial return for spent oxide was often a poor one. With increasing brimstone supplies from Lacq, France, the Gas Council do not expect the export position for spent oxide to improve.

† The Stretford Process—see P.35.

STATISTICAL APPENDIX

UNITED STATES

SULPHUR EXPORTS
(Long tons)

Country	Jan./Aug. 1959	Jan./Aug. 1960	Change
Algeria	9,000	2,000	− 7,000
Antils N.	5,000	1,500	− 7,000
Argentina	23,587	13,919	− 9,668
Australia	76,254	86,514	+10,260
Austria	2,000	4,170	+ 2,170
Bahrain	203	159	− 44
Belgium	41,700	56,859	+15,159
Brazil	91,768	85,011	− 6,757
Canada	177,137	189,318	+12,181
Canary Is.	2,952	4,428	+ 1,476
Columbia	108	—	− 108
Costa Rica	33	—	− 33
Cuba	15,493	19,990	+ 4,497
Czechoslovakia	4,600	12,000	+ 7,400
Denmark	1,000	—	− 1,000
Dominica	399	—	− 399
Egypt	—	5,060	+ 5,060
Finland	10,600	19,064	+ 8,464
France	62,995	39,210	−23,785
Germany, West	52,140	58,381	+ 6,241
Guatemala	50	—	− 50
Honduras	71	—	− 71
India	77,530	89,413	+11,883
Indonesia	5,200	1,900	− 3,300
Iran	2,260	—	− 2,260
Israel	5,030	10,000	+ 4,970
Korean Rep.	68	676	+ 608
Lebanon	1,000	27	− 973
Morocco	—	1,766	+ 1,766
Netherlands	24,800	54,604	+29,804
New Zealand	50,919	54,822	+ 3,903
Nicaragua	—	1,953	+ 1,953
Norway	—	835	+ 835
Pakistan	548	2,290	+ 1,742
Paraguay	97	559	+ 462
Philippines	874	1,013	+ 139
Poland	17,515	12,330	− 5,185
Peru	3,509	7,200	+ 3,691
Saudi Arabia	1,222	728	− 494
South Africa	48,346	33,000	−15,346
Spain	—	2,953	+ 2,953
Sweden	3,200	6,550	+ 3,350
Switzerland	24,900	30,420	+ 5,520
Syria	49	—	− 49
Taiwan	4,133	12,397	+ 8,264
Thailand	—	496	+ 496
Trinidad	—	5,550	+ 5,550
Tunisia	9,000	19,250	+10,250
United Kingdom	174,605	219,509	+44,904
Uruguay	1,780	4,080	+ 2,300
Venezuela	2,291	1,313	− 978
Yugoslavia	2,000	—	− 2,000
Others	—	10	+ 10
TOTAL	**1,037,966**	**1,173,287**	**+135,321**

MEXICO

SULPHUR PRODUCTION

	Pan American Sulphur Company	Gulf Sulphur Corporation	Pemex and Texas Gulf	Negociacion Minera de Azufre S.A.	TOTAL
1959					
January	66,862	23,004	15,000	1,400	**106,266**
February	67,184	24,424	14,060	1,422	**107,090**
March	72,941	26,620	15,620	1,500	**116,681**
April	63,188	25,237	16,000	1,500	**105,925**
May	69,140	23,093	15,200	1,591	**109,024**
June	73,166	25,144	14,500	1,500	**114,310**
July	87,643	26,833	16,000	1,500	**131,976**
August	78,231	25,270	17,000	1,500	**122,001**
September	72,577	23,407	17,000	1,600	**114,584**
October	83,987	20,158	16,480	1,500	**122,125**
November	75,669	20,719	16,800	1,500	**114,688**
December	75,755	18,559	17,000	1,500	**112,814**
1960					
January	72,758	21,127	17,500	1,500	**112,885***
February	68,518	17,885	11,750	1,500	**99,653**
March	71,242	18,740	7,312†	1,500	**98,794**
April	58,155	17,710	7,235	1,500	**84,600**
May	64,538	19,236	7,600	1,500	**92,874**
June	77,775	17,659	7,655	1,500	**104,589**
July	94,936	16,555	7,500	1,500	**120,491**
August	103,192	11,417	7,200	1,500	**123,309**
September	96,632	15,388	6,900	1,500	**120,420**
October	110,548	16,800	6,480	1,500	**135,328**

† Texas Gulf Sulphur ceased operation. * Includes 500 tons produced by Texas International Sulphur Company.

PRINCIPAL SULPHUR IMPORTS OF WESTERN EUROPE (Average price per ton)

SOURCE	Belgium Jan.-July	Finland Jan.-June	U. Kingdom Jan.-Oct.	Netherlands Jan.-Aug.	Sweden Jan.-Aug.	W.Germany Jan.-Sept.	Norway Jan.-Aug.	Denmark Jan.-Sept.	France Jan.-Aug.
United States									
1960	30,732	6,802	262,437	50,838		52,759			
	£9.96	£11.05	£10.51	£9.80		£9.91			
1959	48,492	12,593	224,743	2,033		43,137			
	£10.07		£10.77	£8.30		£10.23			
Mexico									
1960	45,221		66,725			45,354			
	£9.09		£10.00			£9.13			
1959	14,073		51,530	19,610		38,495			
	£8.81		£10.43	£9.56		£9.49			
France									
1960	16,859	15,959	77,842	15,717		32,270			
	£9.41	£10.90	£10.63	£10.56		£9.99			
1959	13,981	3,186	37,145	5,854		19,295			
	£10.09		£10.92	£9.41		£10.00			
Italy									
1960						111			
						£46.97			
1959									
Netherlands									
1960	3,568								
	£9.19								
1959	2,570								
	£8.81								
U.S.S.R.									
1960	4,169	7,565		1,004					
	£8.75	£10.00		£11.00					
1959		2,493							
Norway									
1960		8,964							
		£11.29							
1959		2,093							
TOTAL									
1960	**101,755**	**40,617**	**407,116**	**68,339**	**49,476**	**130,705**	**2,474**	**3,052**	**114,703**
	£9.39	**£10.80**	**£10.45**	**£9.25**	**£10.77**	**£9.65**	**£10.76**	**£12.20**	**£9.89**
1959	**79,344**	**20,445**	**313,428**	**28,407**	**44,523**	**66,316**		**2,454**	**144,822**
	£9.85		**£10.79**		**£10.76**	**£10.15**		**£13.18**	**£9.40**

PRINCIPAL PYRITES IMPORTS (Tons metric)

SOURCE	Denmark Jan.-Sept.	Belgium-Lux Jan.-July	France Jan.-Aug.	Italy Jan.-Aug.	Netherlands Jan.-Aug.	United Kingdom Jan.-Sept.	West Germany Jan.-Oct.
Eire							
1960		1,804				5,121	1,805
1959		1,721				1,236	
Italy							
1960					116,494	2	
1959					71,446		863
Yugoslavia							
1960				58,207			101,828
1959							55,293
Norway							
1960					10,686		223,499
1959					11,858		165,549
Portugal							
1960		109,942			51,485		63,179
1959		82,313			71,109		56,575
Sweden							
1960						16,110	3,042
1959		220				20,530	
U.S.S.R.							
1960							1,340
1959							
Spain							
1960		102,897			19,249	8,035	474,288
1959		73,776			11,833	29,035	408,016
Turkey							
1960							38,087
1959							31,714
Cyprus							
1960		36,308		104,050	46,743	186,000	279,936
1959		46,876		62,458	78,177	130,600	327,988
Greece							
1960					15,580		
1959					11,230		
Canada							
1960						7,385	22,015
1959						26,050	
Cuba							
1960		14,458					50,361
1959							24,943
Total							
1960	**105,670**	**265,408**	**349,824**	**172,137**	**260,237**	**223,500**	**1,374,717**
1959	**93,091**	**204,916**	**331,655**	**104,575**	**256,598**	**198,500**	**1,091,974**

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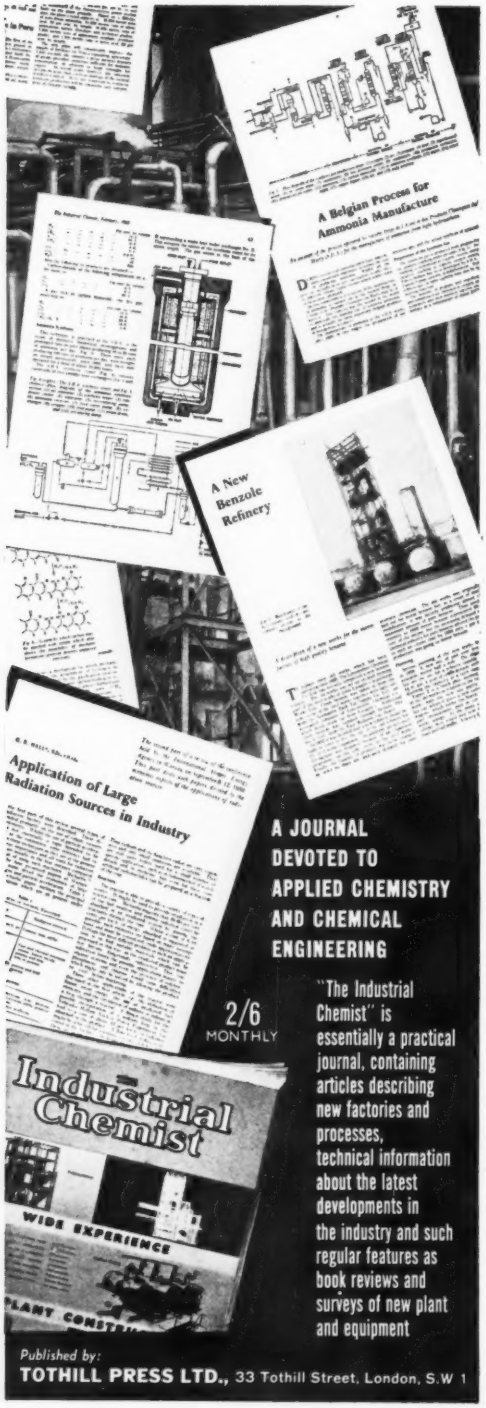
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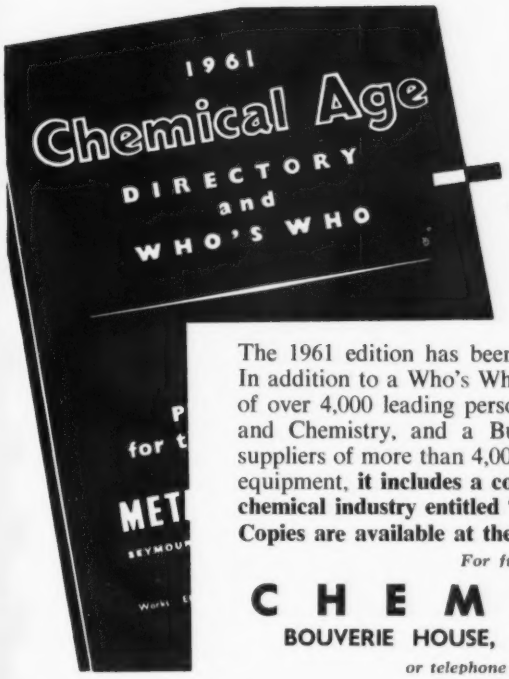

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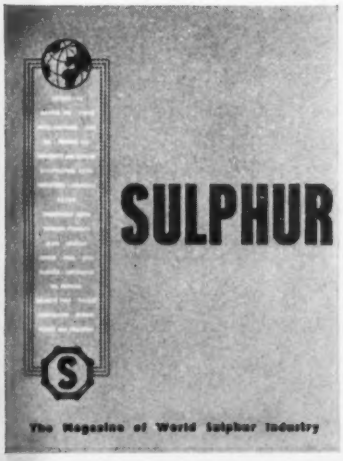

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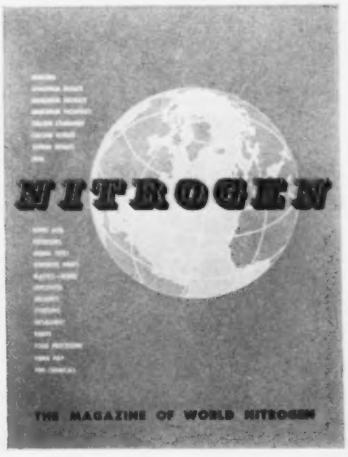

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